EXHIBIT 2

IN THE UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF TEXAS
WACO DIVISION

THE TRUSTEES OF PURDUE UNIVERSITY, Plaintiff, v. STMICROELECTRONICS N.V. and STMICROELECTRONICS, INC., Defendants.	Civil Action No. 6:21-cv-00727-ADA JURY TRIAL DEMAND

EXPERT REPORT OF DR. JAMES A. COOPER
REGARDING
INFRINGEMENT OF U.S. PATENT NO. 7,498,633

James A. Cooper

Dr. James A. Cooper
June 9, 2023

case must include experience in designing and fabricating SiC power semiconductor devices. Based on my education and experience, I meet the qualifications of such person of ordinary skill and know what a POSITA would and would not know.

V. OPINIONS

42. Based on my review of the materials available to me, it is my opinion that the Accused Products infringe claims 9 and 10 of the ’633 Patent. As discussed above, I have focused my analysis on the representative products: SCT055HU65G3AG, SCT040H65G3AG, SCT10000N170, SCTW70N120G2V, and Telsa Drive Inverter.

A. The Accused Products Infringe Claim 9

1. “A double-implanted metal-oxide semiconductor field effect transistor”

46. I understand that the Court has construed the preamble, “A double-implanted metal-oxide semiconductor field effect transistor” to be limiting. Dkt. 220 at 25. In my opinion, the Accused Products meet this portion of claim 9. Double-implantation refers to a planar power MOSFET in which the p-type base region and n+ source region are each formed by ion implantation. Double-implanted MOSFETs (or DMOSFETs) can actually have more than two implants, but the term “double-implanted” refers specifically to how the base and source regions are formed.

47. As a threshold point, there is no way to achieve the accused SiC power MOSFET devices without double implantation. The very fact that the Accused Products are SiC power MOSFET devices means that they are double implanted or have at least two implants. A person of ordinary skill would understand this.

48. Further, the datasheets for the representative products describe each of the products as a “silicon carbide power MOSFET.”

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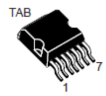
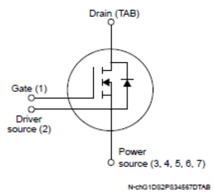
SCT040H65G3AG

Datasheet

Automotive-grade silicon carbide Power MOSFET 650 V, 40 mΩ typ., 30 A in an H²PAK-7 package



H²PAK-7



Features

Order code	V_{DS}	$R_{DS(on)}$ max.	I_D
SCT040H65G3AG	650 V	55 mΩ	30 A

- AEC-Q101 qualified
- Very low $R_{DS(on)}$ over the entire temperature range
- High speed switching performances
- Very fast and robust intrinsic body diode
- Source sensing pin for increased efficiency

Applications

- Main inverter (electric traction)
- DC/DC converter for EV/HEV
- On board charger (OBC)

Description

This silicon carbide Power MOSFET device has been developed using ST's advanced and innovative 3rd generation SiC MOSFET technology. The device features a very low $R_{DS(on)}$ over the entire temperature range combined with low capacitances and very high switching operations, which improve application performance in frequency, energy efficiency, system size and weight reduction.

STPOWER

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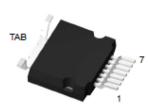
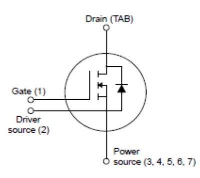
SCT055HU65G3AG

Datasheet

Automotive-grade silicon carbide Power MOSFET 650 V, 58 mΩ typ., 30 A in an HU3PAK package



HU3PAK



Features

Order code	V_{DS}	$R_{DS(on)}$ typ.	I_D
SCT055HU65G3AG	650 V	58 mΩ	30 A

- AEC-Q101 qualified
- Very low $R_{DS(on)}$ over the entire temperature range
- High speed switching performances
- Very fast and robust intrinsic body diode
- Source sensing pin for increased efficiency

Applications

- Main inverter (electric traction)
- DC/DC converter for EV/HEV
- On board charger (OBC)

Description

This silicon carbide Power MOSFET device has been developed using ST's advanced and innovative 3rd generation SiC MOSFET technology. The device features a very low $R_{DS(on)}$ over the entire temperature range combined with low capacitances and very high switching operations, which improve application performance in frequency, energy efficiency, system size and weight reduction.

STPOWER

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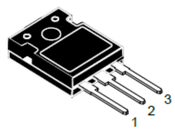
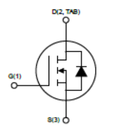
SCT1000N170

Datasheet

Silicon carbide Power MOSFET 1700 V, 1.0 Ω typ., 7 A in an HiP247 package



HiP247



Features

Order code	V_{DS}	$R_{DS(on)}$ max.	I_D
SCT1000N170	1700 V	1.3 Ω	7 A

- High speed switching performance
- Very fast and robust intrinsic body diode
- Low capacitances
- Very high operating junction temperature capability (T_J = 200 °C)

Applications

- Auxiliary power supply for server
- Switch mode power supply

Description

This silicon carbide Power MOSFET is produced exploiting the advanced, innovative properties of wide bandgap materials. This results in unsurpassed on-resistance per unit area and very good switching performance almost independent of temperature. The outstanding thermal properties of the SiC material, combined with the device's housing in the proprietary HiP247 package, allows designers to use an industry standard outline with significantly improved thermal capability. These features render the device perfectly suitable for high-efficiency and high power density applications.

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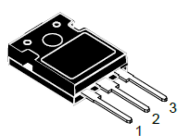
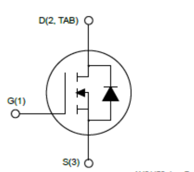
SCTW70N120G2V

Datasheet

Silicon carbide Power MOSFET 1200 V, 91 A, 21 mΩ (typ., T_J = 25 °C) in an HiP247 package



HiP247



Features

Order code	V_{DS}	$R_{DS(on)}$ typ.	I_D
SCTW70N120G2V	1200 V	21 mΩ	91 A

- Very high operating junction temperature capability (T_J = 200 °C)
- Very fast and robust intrinsic body diode
- Extremely low gate charge and input capacitances

Applications

- Charger
- Power supply for renewable energy systems
- High frequency DC-DC converters

Description

This silicon carbide Power MOSFET is produced exploiting the advanced, innovative properties of wide bandgap materials. This results in unsurpassed on-resistance per unit area and very good switching performance almost independent of temperature. The outstanding thermal properties of the SiC material allow designers to use an industry-standard outline with significantly improved thermal capability. These features render the device perfectly suitable for high-efficiency and high power density applications.

49. It does not appear that Defendants produced a datasheet (or provided a part number for the Tesla Drive Inverter); however, Defendants have described the part as a SiC MOSFET.

16 May 2016 | Geneva

English | French | Italian

STMicroelectronics Reveals Advanced Silicon-Carbide Power Devices to Accelerate Automotive Electrification

- *Complete set of devices allows full conversion of auto power modules to silicon carbide (SiC) for greater vehicle range, convenience, and reliability*
- *Advanced 6-inch wafer capability and process to bring superior SiC offer to carmakers and automotive suppliers*
- *AEC-Q101 qualification program to complete in early 2017, ready for new OEM product launches*

Geneva / 16 May 2016
STMicroelectronics (NYSE: STM), a global semiconductor leader serving customers across the spectrum of electronic applications, has announced advanced high-efficiency power semiconductors for Hybrid and Electric Vehicles (EVs) with a timetable for qualification to the automotive quality standard AEC-Q101.

In EVs and hybrids, where better electrical efficiency means greater mileage, ST's latest silicon-carbide (SiC) technology enables auto makers to create vehicles that travel further, recharge faster, and fit better into owners' lives. A leader in silicon carbide, ST is among the first to present new-generation rectifiers and MOSFETs for high-voltage power modules and discrete solutions addressing all the vehicle's main electrical blocks. These include the traction inverter, OBC (On-Board Charger), and auxiliary DC-DC converter.

Today's power modules typically rely on standard silicon diodes and Insulated Gate Bipolar Transistors (IGBTs). Silicon carbide is a newer, wide-bandgap technology that allows smaller device geometries capable of operating well above the 400V range of today's electric and hybrid drivetrains. The smaller SiC diode and transistor structures present lower internal resistance and respond more quickly than standard silicon devices, which minimize energy losses and allow associated components to be smaller, saving even more size and weight.

https://www.st.com/content/st_com/en/about/media-center/press-item.html/p3830.html

50. In addition to the fundamental notion that the devices cannot be made without two implantations, the reverse engineering results referenced below further confirm that the Accused Products are double-implanted. The SEM and SCM imaging for the representative products shows features formed by at least two implantations.

51. Given this information, is it clear that the Accused Products are double-implanted MOSFETs as required by the preamble of claim 9.

52. To the extent the Defendants or their expert argue that the polysilicon used in the gates of the Accused Products is not a "metal," the Accused Products nevertheless infringe because (1) a person of ordinary skill in the art would understand that polysilicon is commonly used as the

gate electrode in MOSFETs, and that it is formed in a way to make it electrically "metallic," and (2) polysilicon performs substantially the same function as pure metal in substantially the same way to achieve the same result in semiconductor gates, meaning that the Accused Products would infringe under the DOE as I understand the doctrine.

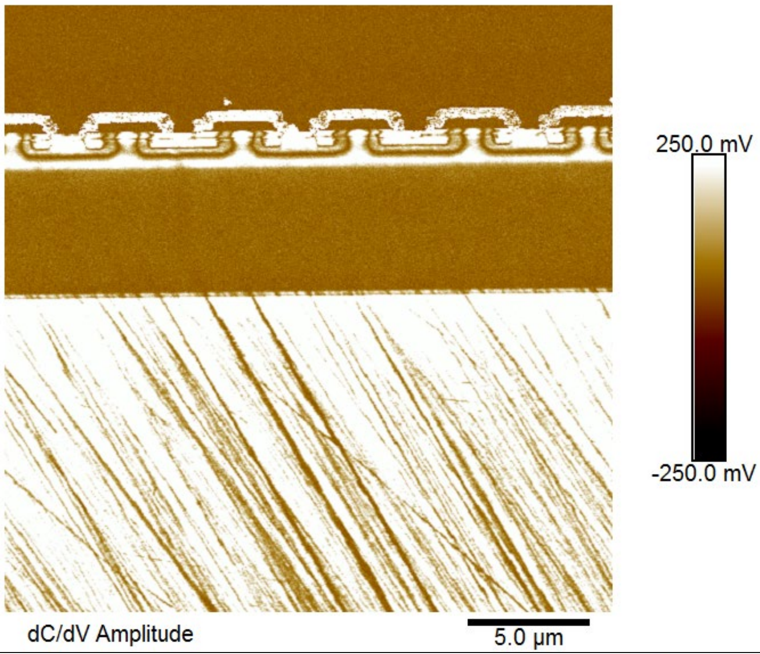
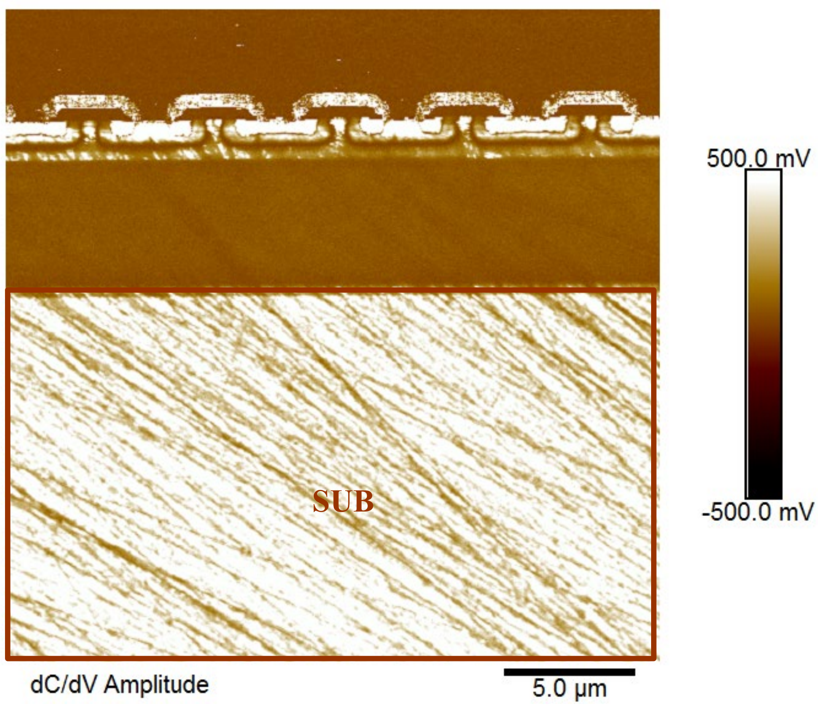
53. Given this, it is my opinion the Accused Products meet this limitation of claim 9.

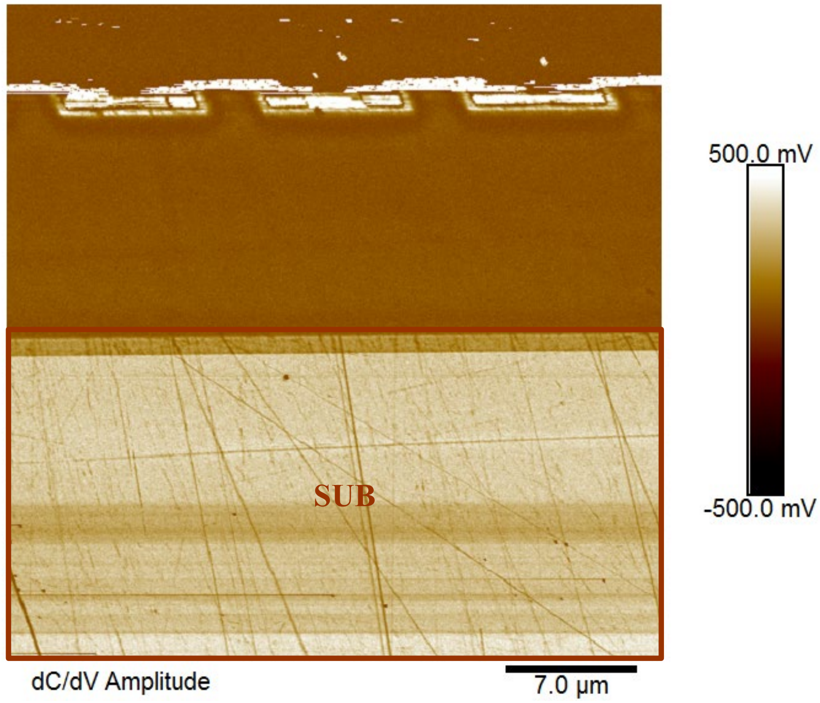
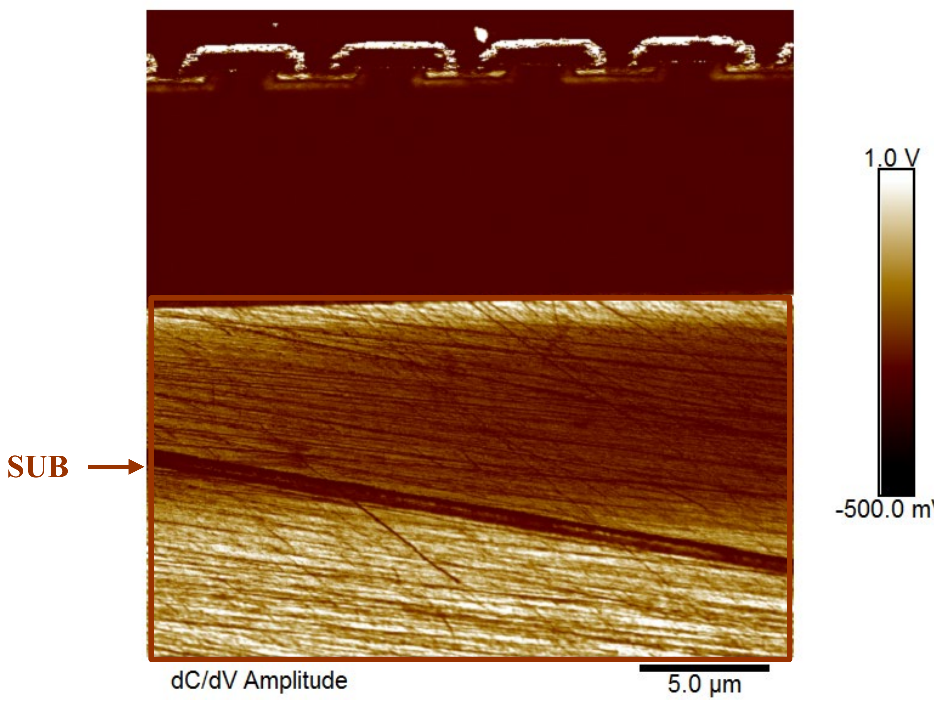
2. "a silicon carbide substrate"

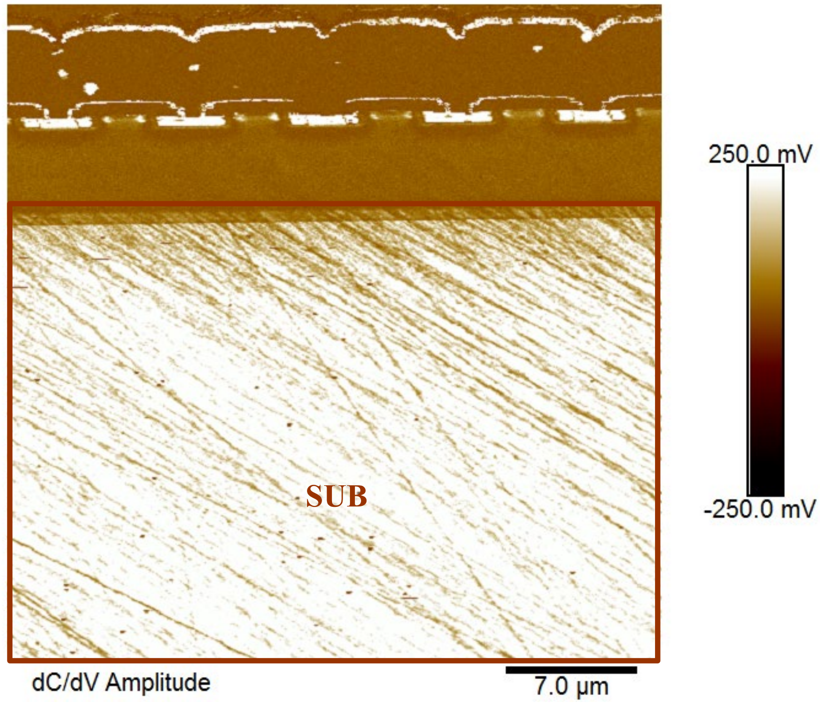
54. The Accused and Representative Products meet this claim limitation as well because each of them includes an SiC substrate. Again, the datasheets and other publicly available descriptions of the products confirm the presence of an SiC substrate, as described above in reference to the preamble. Nothing in the '633 Patent requires the SiC substrate to be uniformly doped, only that it be comprised of SiC.

55. The scanning electron microscopy (SEM) images of the representative products confirms that they include an SiC substrate. To be clear, while the SEM and SCM imaging does not show the material used, the combination of the imaging with the datasheets confirms the presence of SiC as the substrate.

Product	Image

SCT055HU65G3AG	
SCT040H65G3AG	

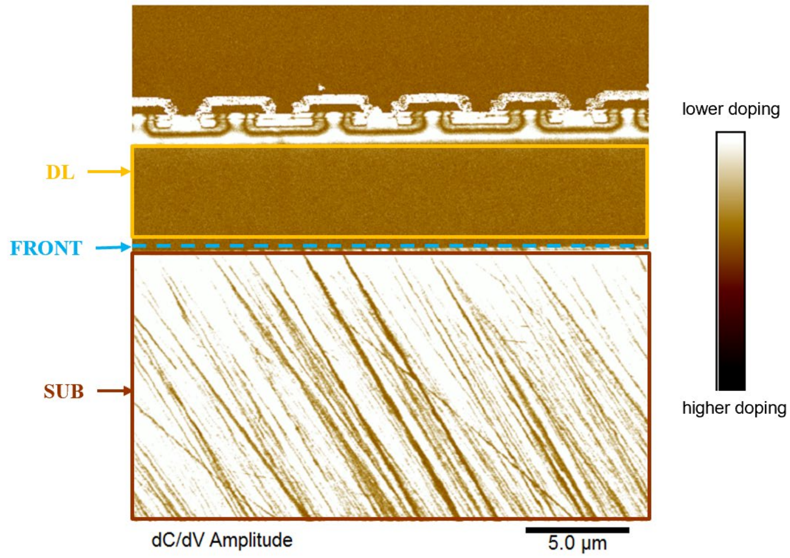
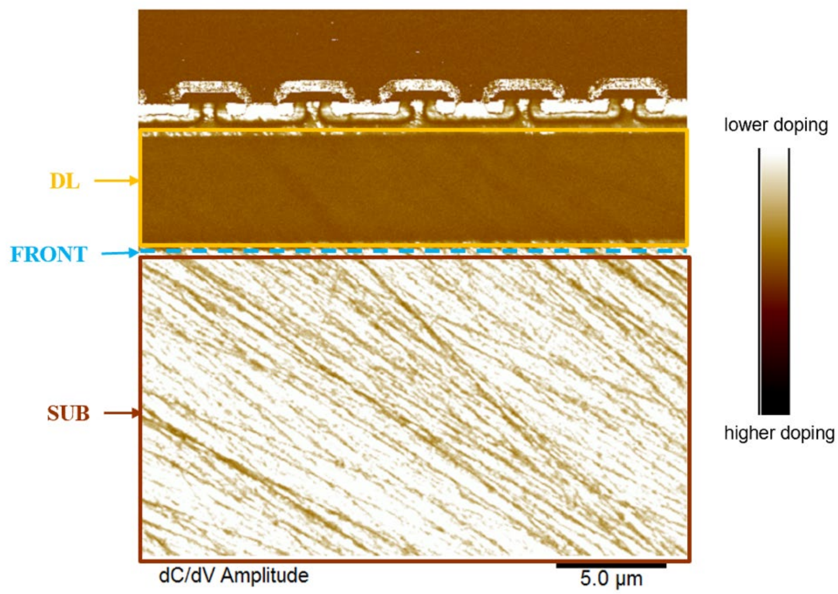
SCT1000N170	
SCTW70N120G2V	

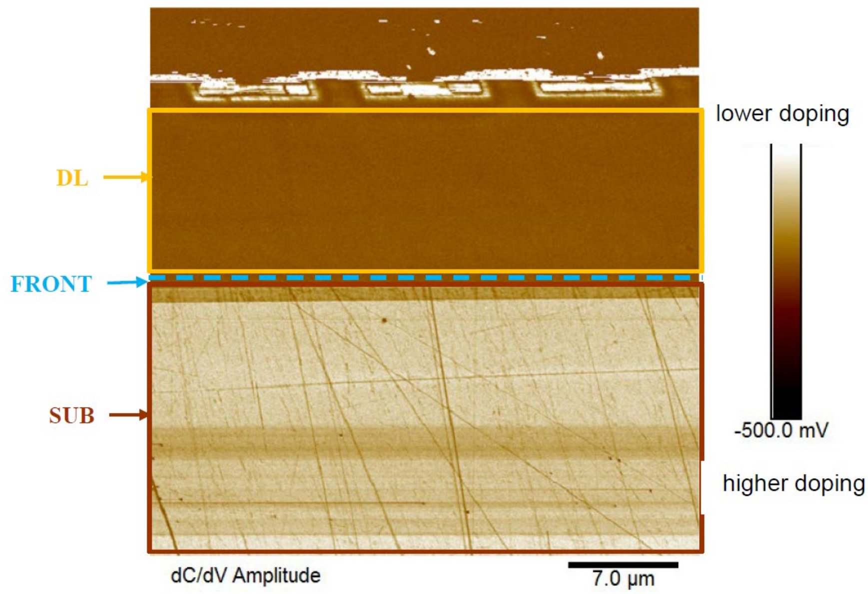
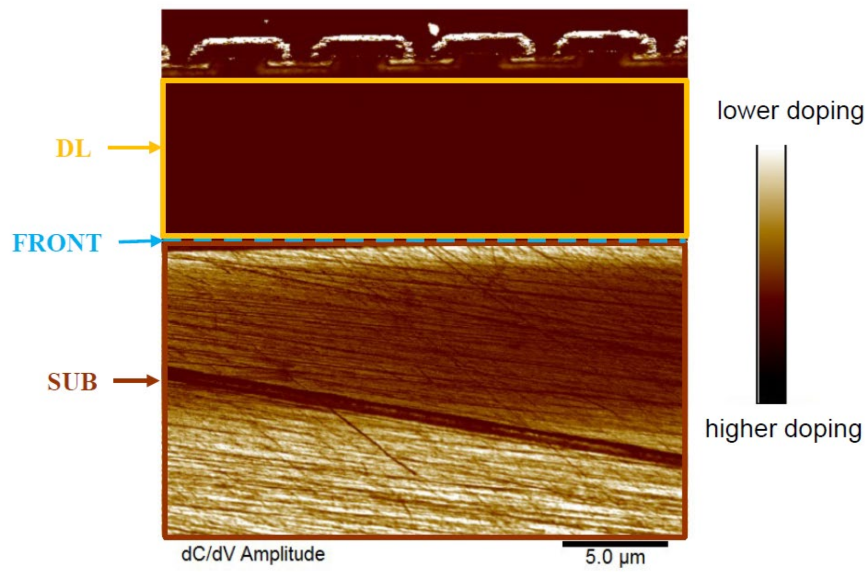
Tesla Inverter	 **Scanning Capacitance Microscopy of the framed area**

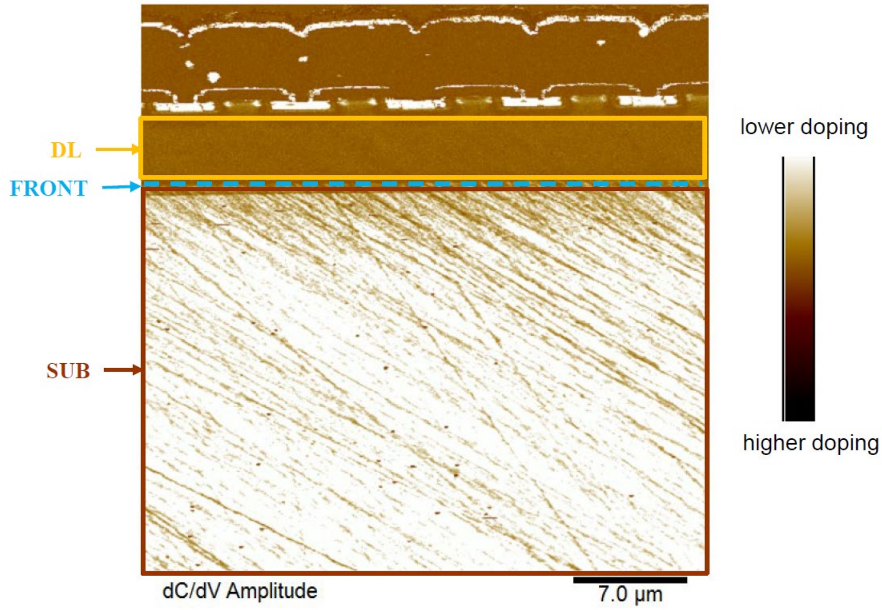
56. Given this, it is my opinion the Accused Products meet this limitation of claim 9.

3. <u>"a drift semiconductor layer formed on a front side of the semiconductor substrate"</u>

57. The Accused Products each comprise a SiC MOSFET with a drift semiconductor layer formed on a front side of the semiconductor substrate. Under the claim language, the "semiconductor substrate" is the silicon carbide substrate referenced in the prior claim limitation. The claim language does not specify what kind of semiconductor is used for the drift semiconductor layer. The Accused Products each include an epitaxial layer formed on the SiC substrate. The scanning electron microscopy (SEM) images of the representative products combined with the knowledge gleaned from the publicly available datasheets and my understanding of the formation of these devices, confirms that they include a drift semiconductor layer formed on a front side of the semiconductor substrate. .

Representative Product	**Image**
SCT055HU65G3AG	
SCT040H65G3AG	

SCT1000N170	
SCTW70N120G2V	

Tesla Inverter	

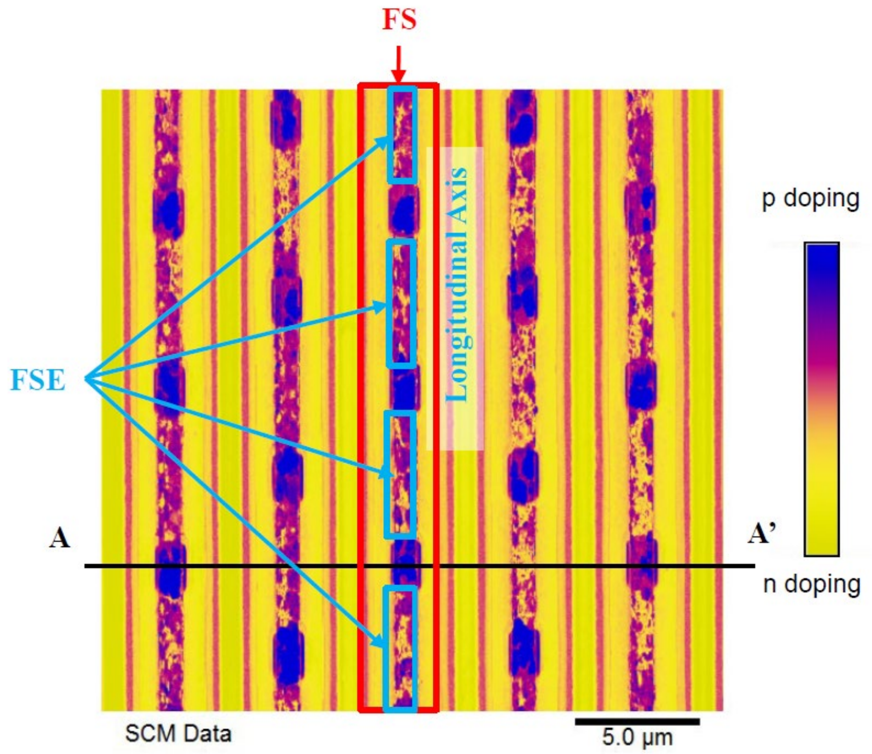
58. Given this, it is my opinion the Accused Products meet this limitation of claim 9.

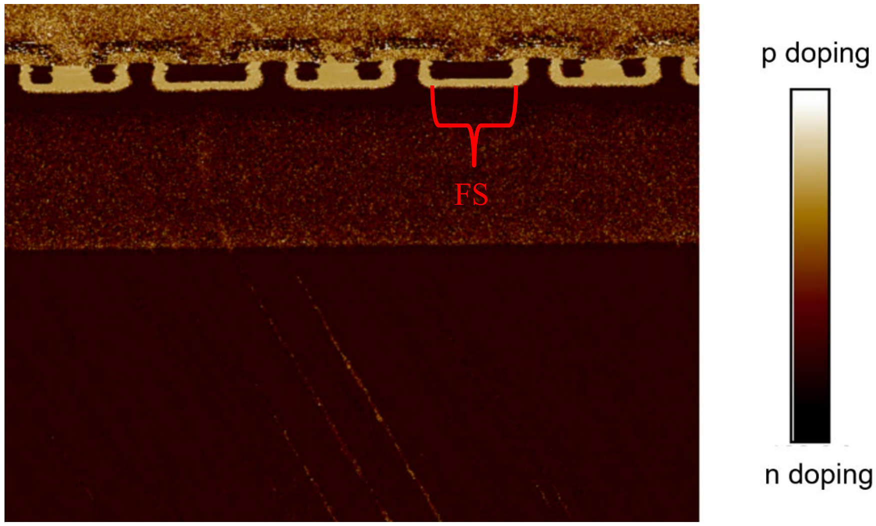
4. <u>"a first source region"/ "a first source electrode formed over the first source region, the first source electrode defining a longitudinal axis"</u>

59. Claim 9 requires "a first source region" and a "first source electrode formed over the first source region, the first source electrode defining a longitudinal axis." Each of the Accused and Representative products has "a first source region" and "first source electrode formed over the first source region, the first source electrode defining a longitudinal axis." The patent specification explains that an electrode is where the metal touches the source region. *See* '633 Patent at 7:4-5 ("A source metallic electrode 50, 52 is formed over the source regions 46, 48, respectively."). The specification also explains, by way of exemplary reference to Figure 1, that "[a] source metallic electrode 50, 52, is formed over the source regions 46, 48, respectively." '633 Patent at 7:4-6.

60. The scanning capacitance microscopy (SCM) imaging proves that the Accused and Representative products meet these claim limitations.

Representative	Image

<table>
<tr><th>Product</th><th></th></tr>
<tr><td>SCT055HU65G3AG</td><td>

(top view of the device after polishing)

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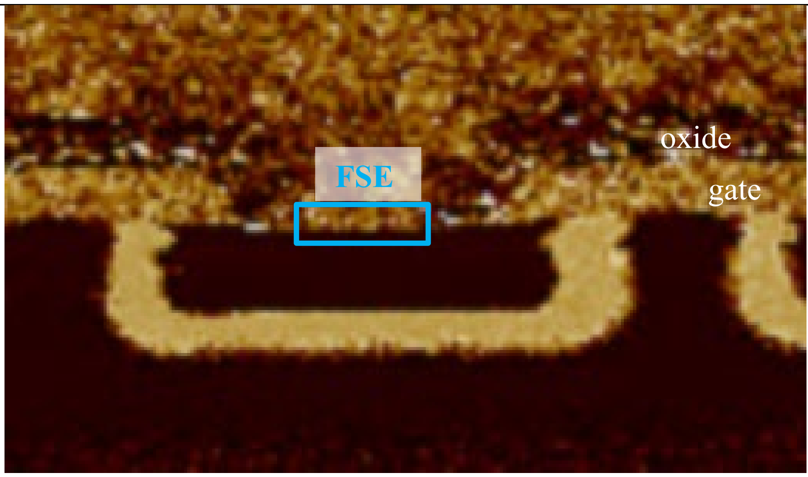
<tr><td></td><td>
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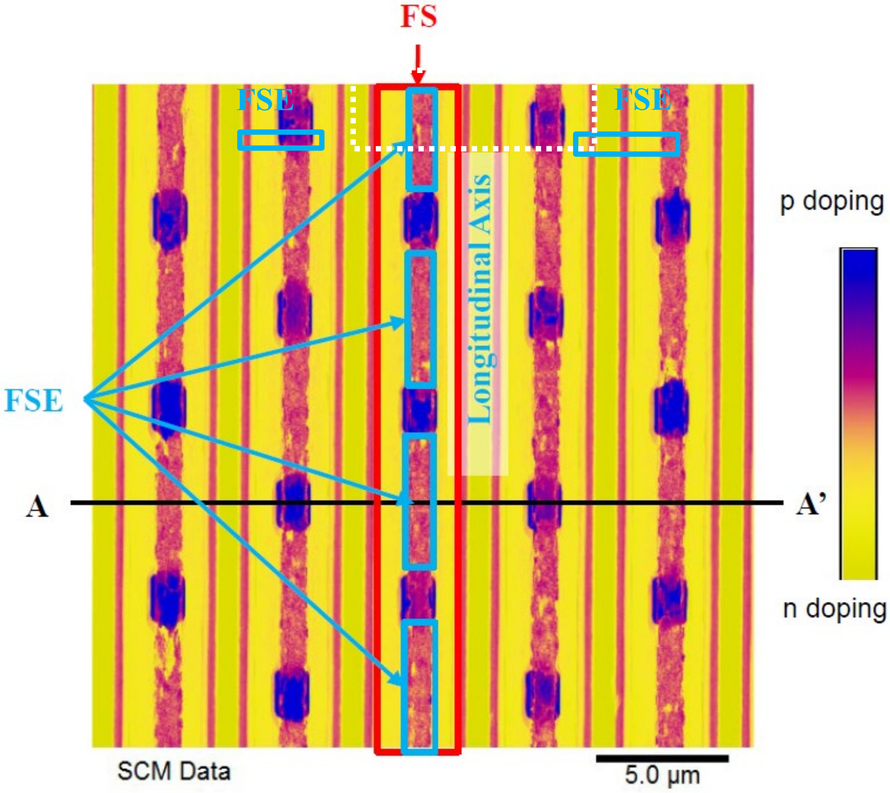
<tr><td>SCT040H65G3AG</td><td>

(top view of the device after polishing)</td></tr>
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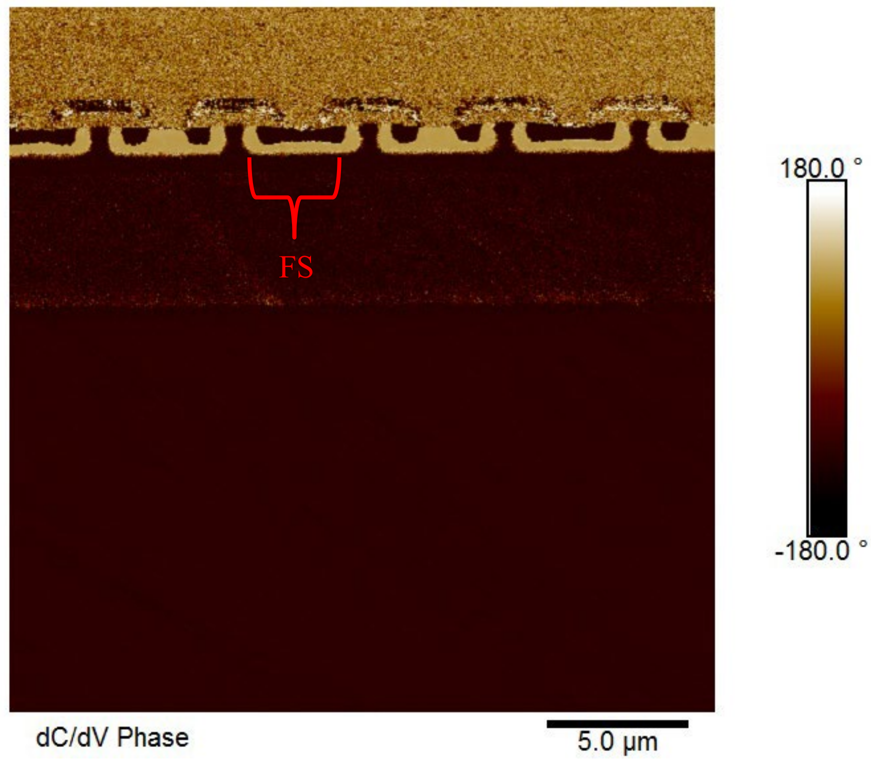
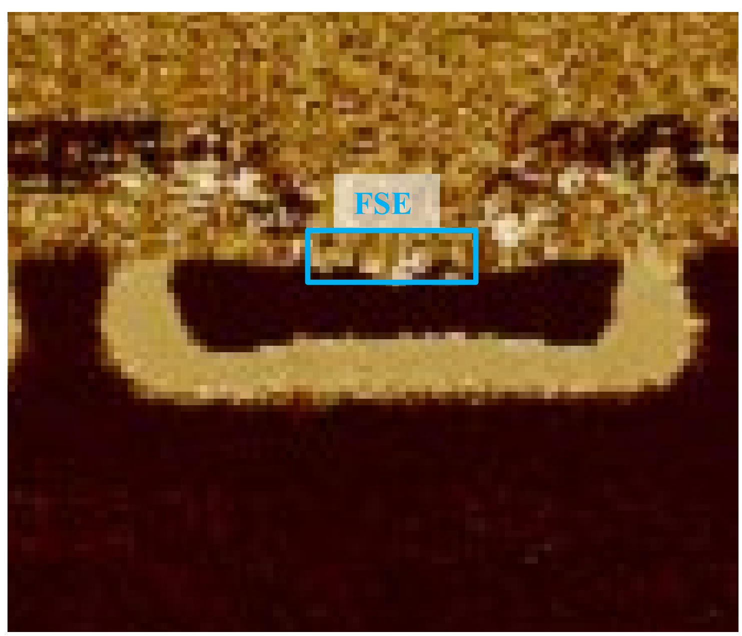

FS
180.0 °
-180.0 °
dC/dV Phase
5.0 µm


FSE

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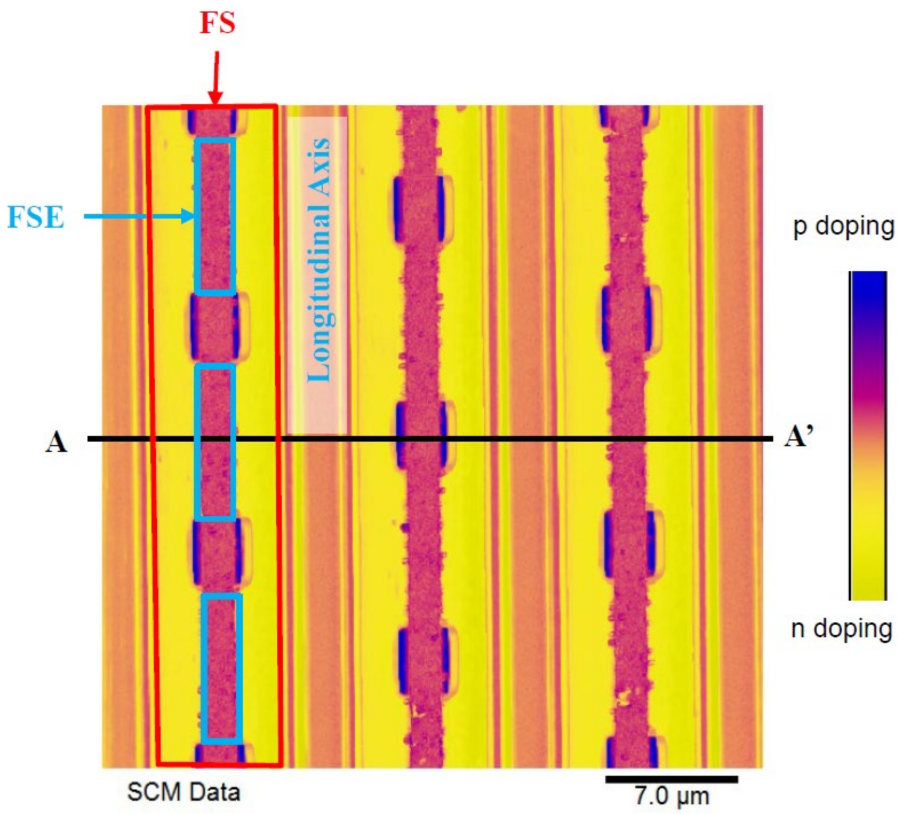
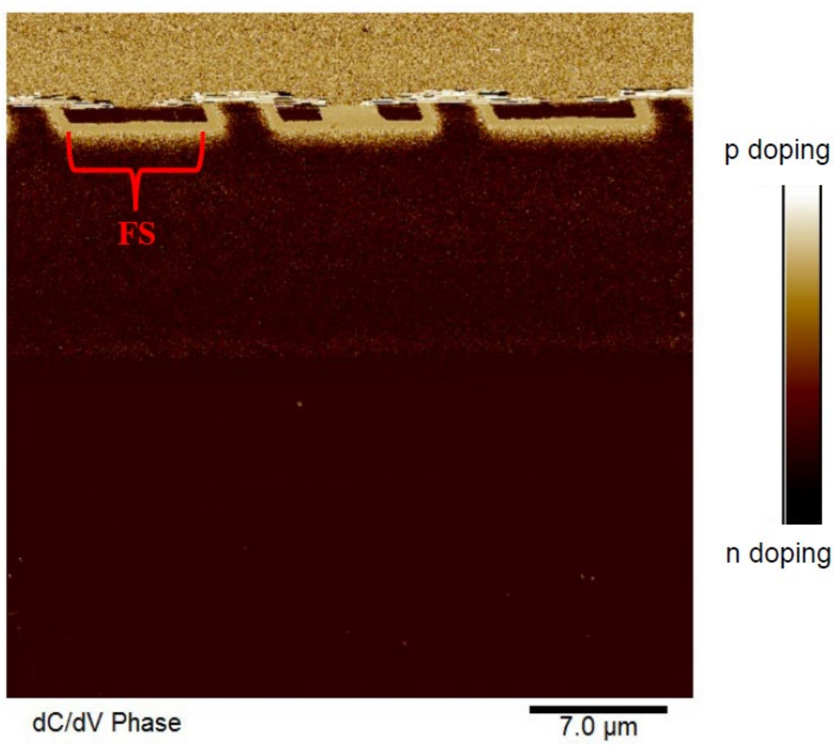
<td>

(top view of the device after polishing)

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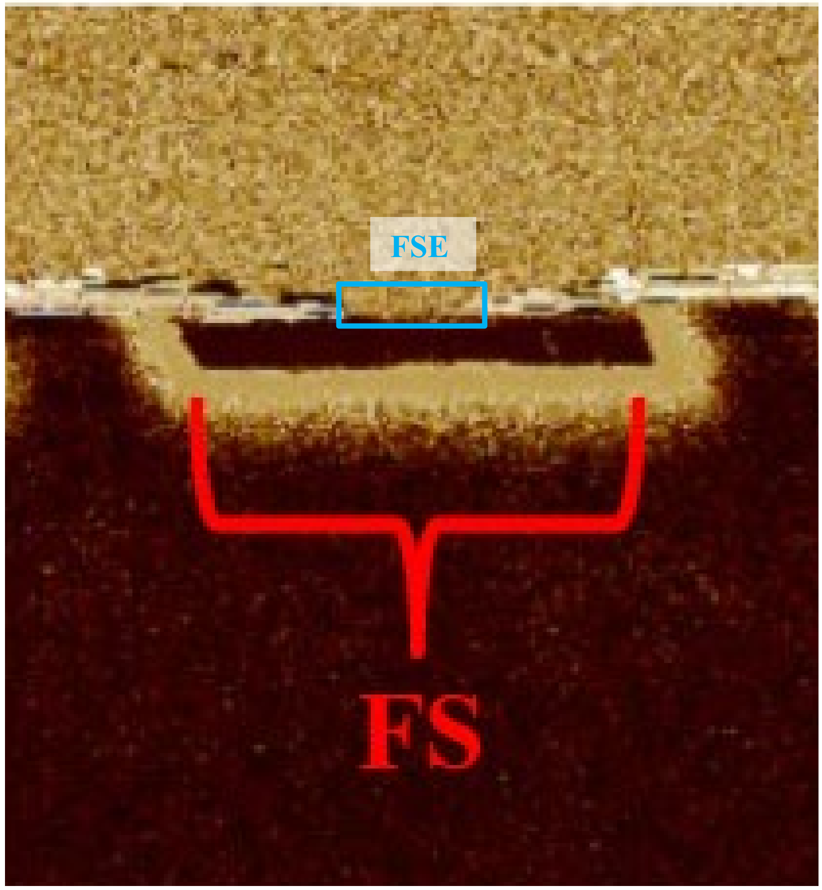
<tr><td></td><td>
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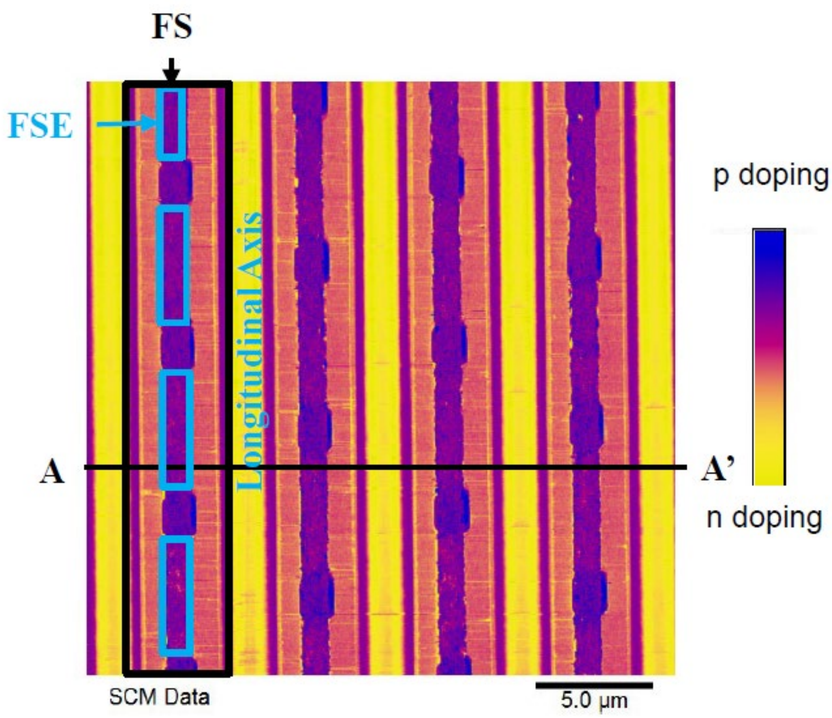
<tr><td>SCTW70N120G2V</td><td>

(top view of the device after polishing)</td></tr>
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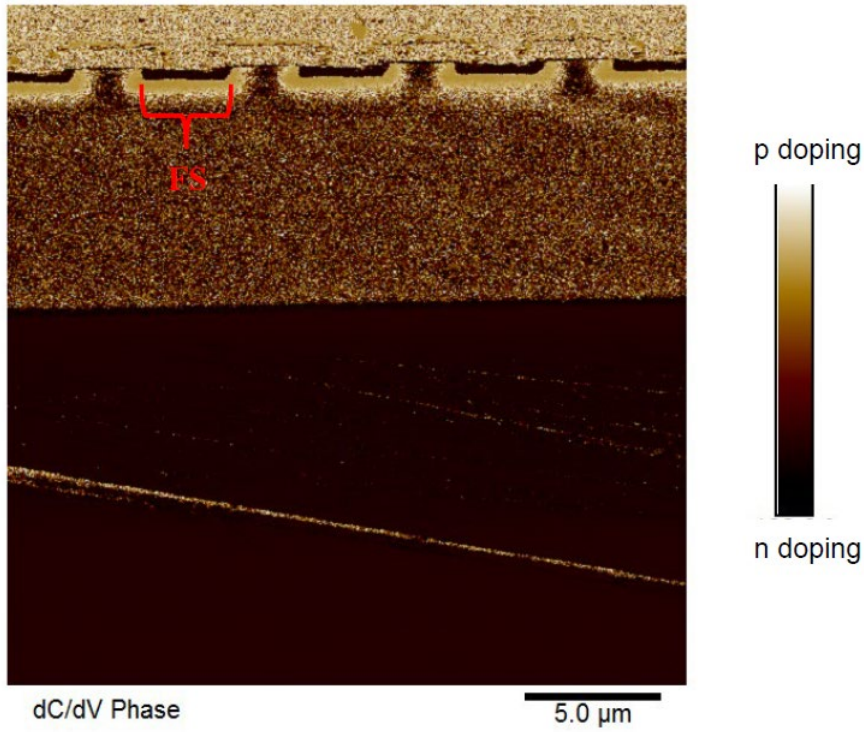
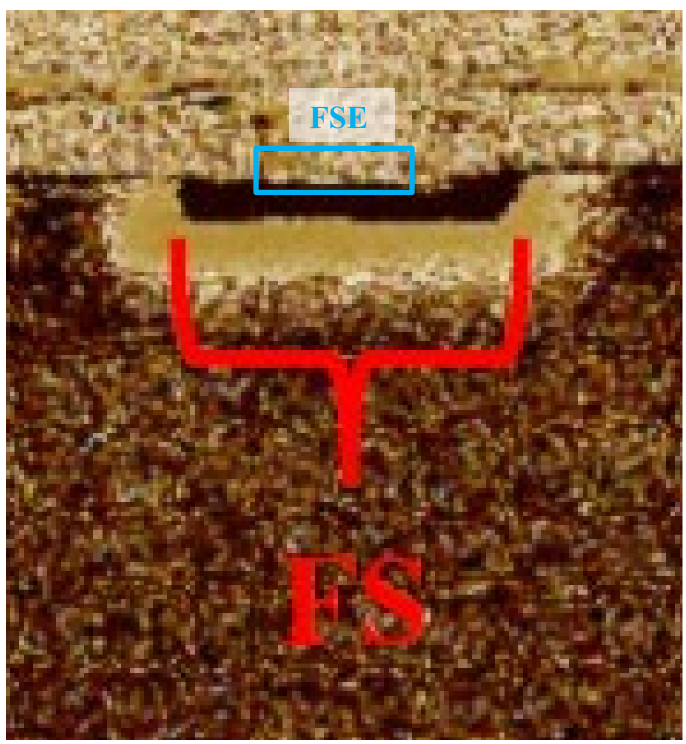
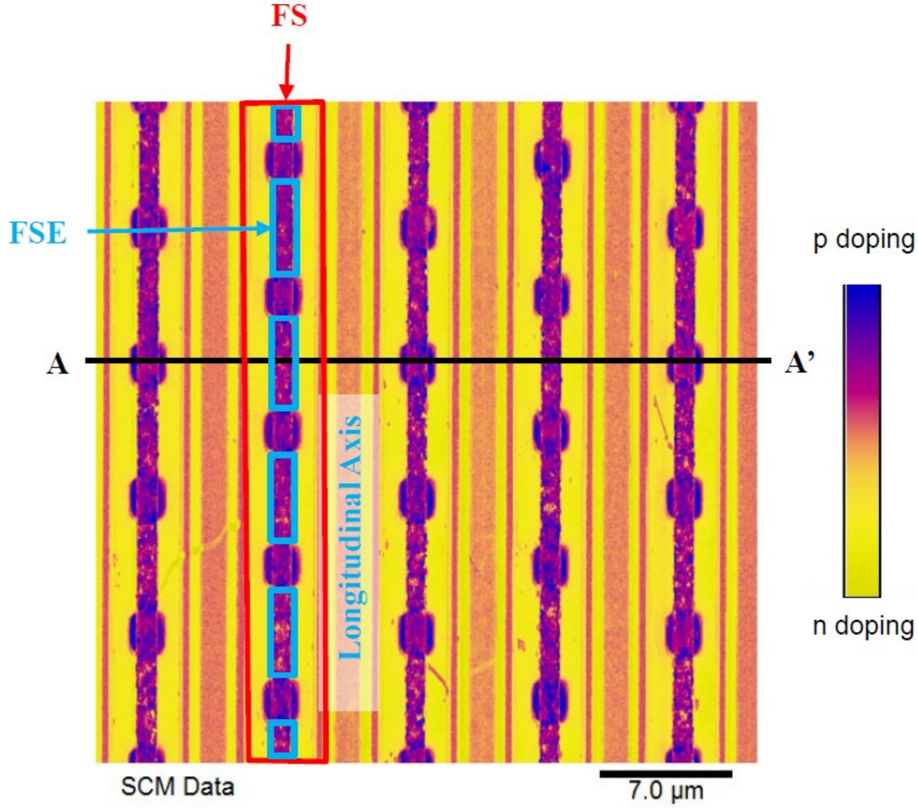
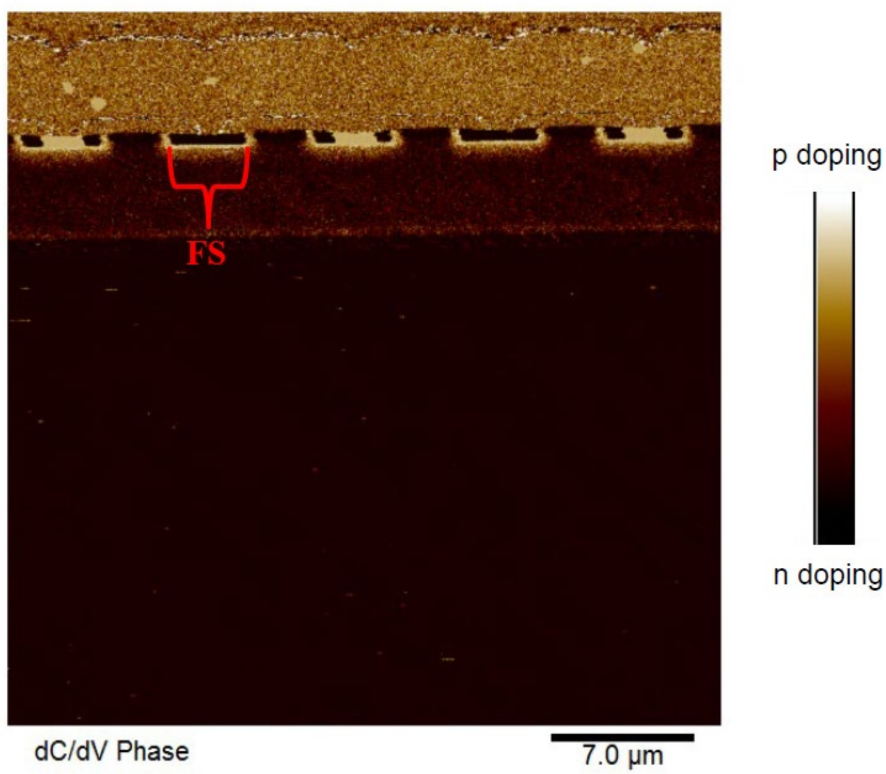
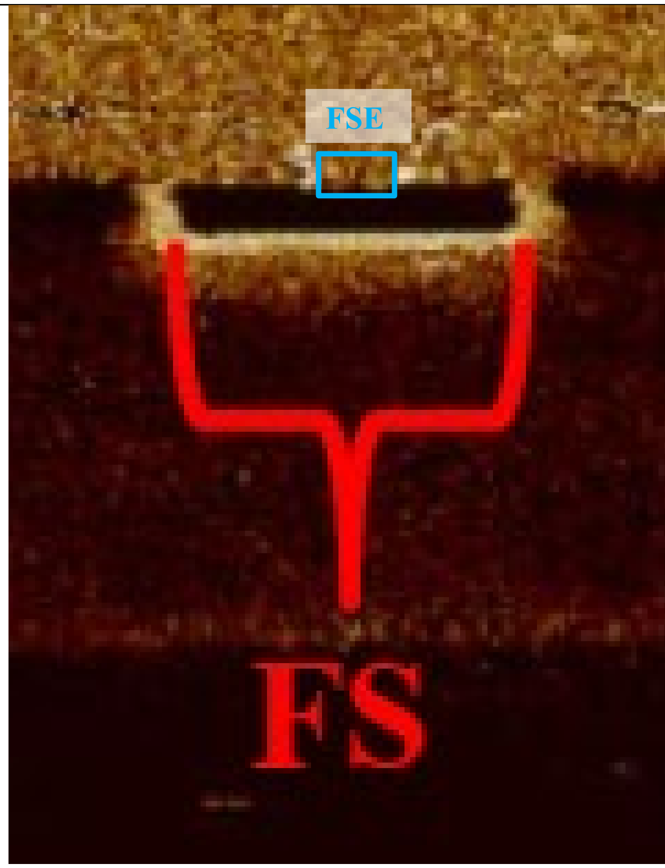

FS
p doping
n doping
dC/dV Phase
5.0 µm


FSE
FS

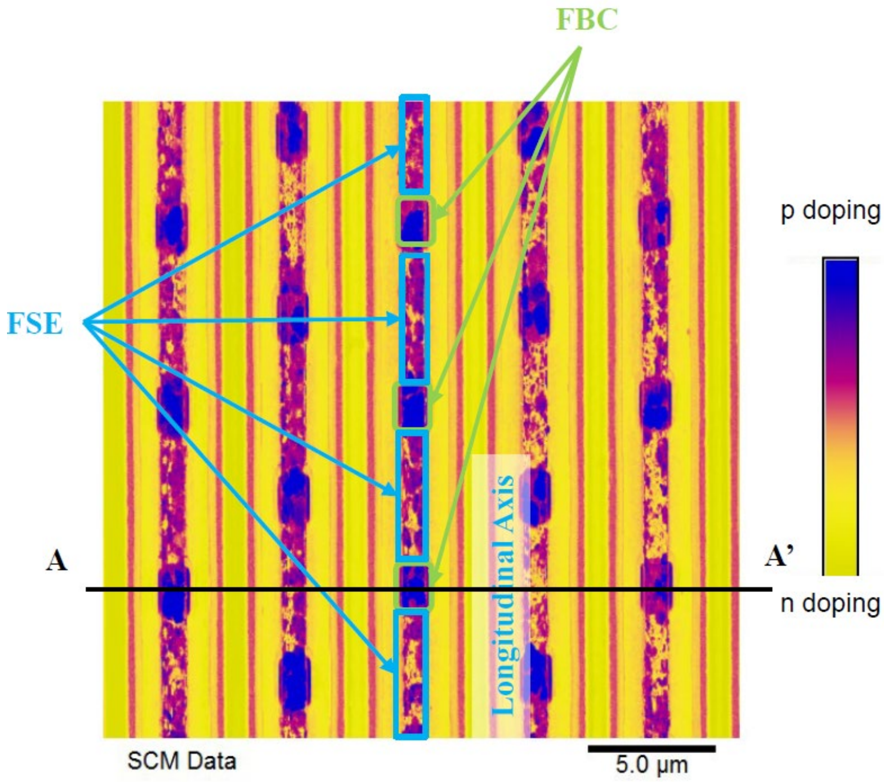
Tesla Inverter	 (top view of the device after polishing) 

61. Given this, it is my opinion the Accused Products meet this limitation of claim 9.

5. <u>"a plurality of first base contact regions defined in the first source region, each of the plurality of first base contact regions being spaced apart from each other in a direction parallel to the longitudinal axis defined by the first source electrode"</u>

62. The Accused and Representative Products include this limitation, which refers to the segmented base contacts described in the '633 Patent. The top-down views using scanning capacitance microscopy provide strong evidence that the Accused Products meet this limitation.

Representative Product	Image
SCT055HU65G3AG	

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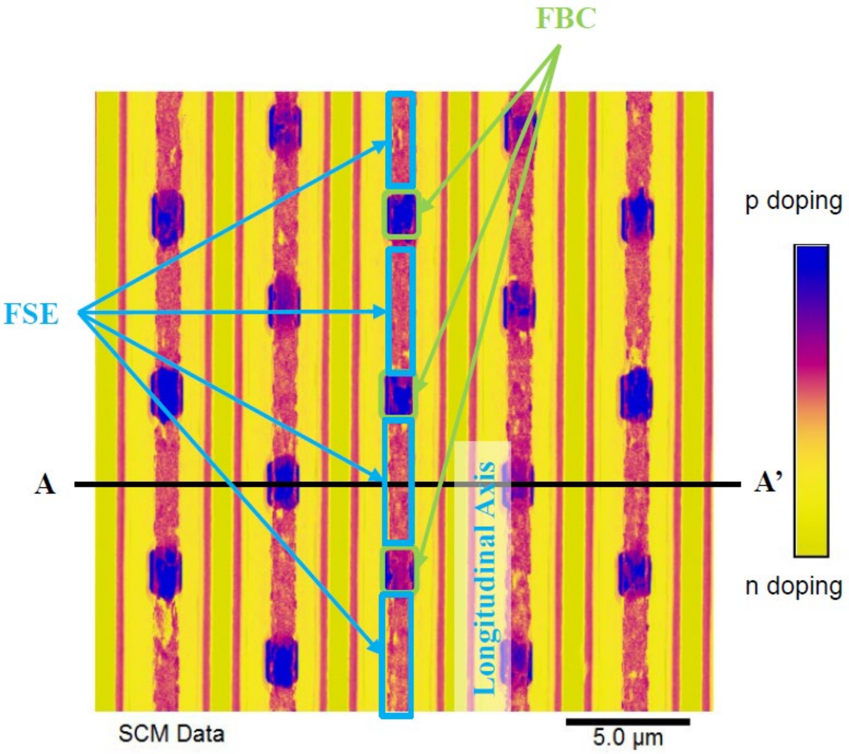
<tr><td>SCT040H65G3AG</td><td>
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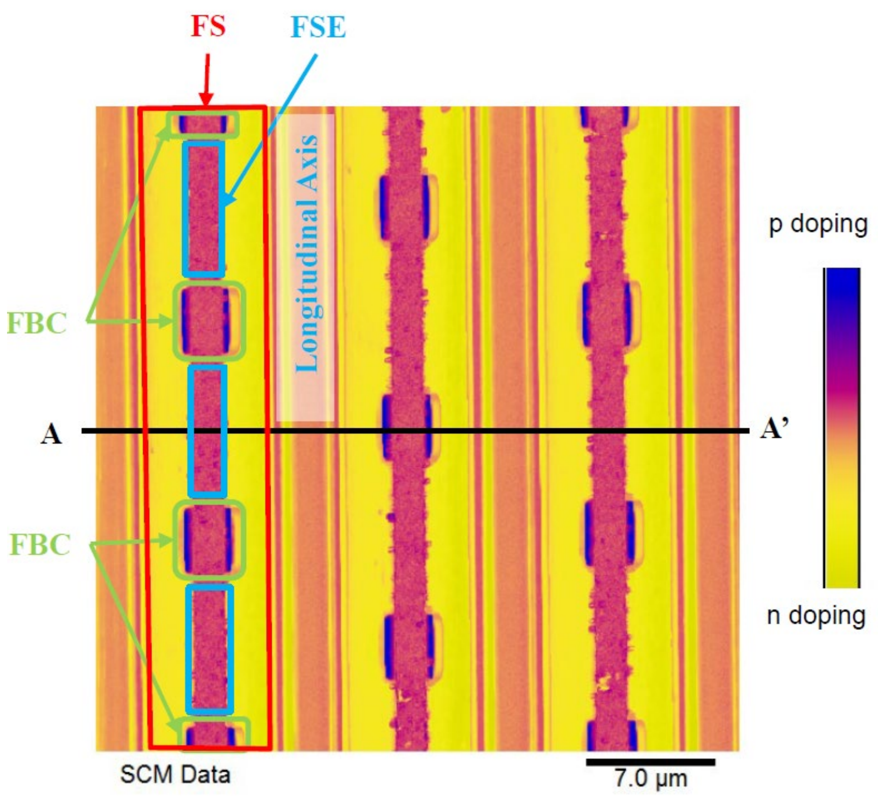
<tr><td>SCT1000N170</td><td>
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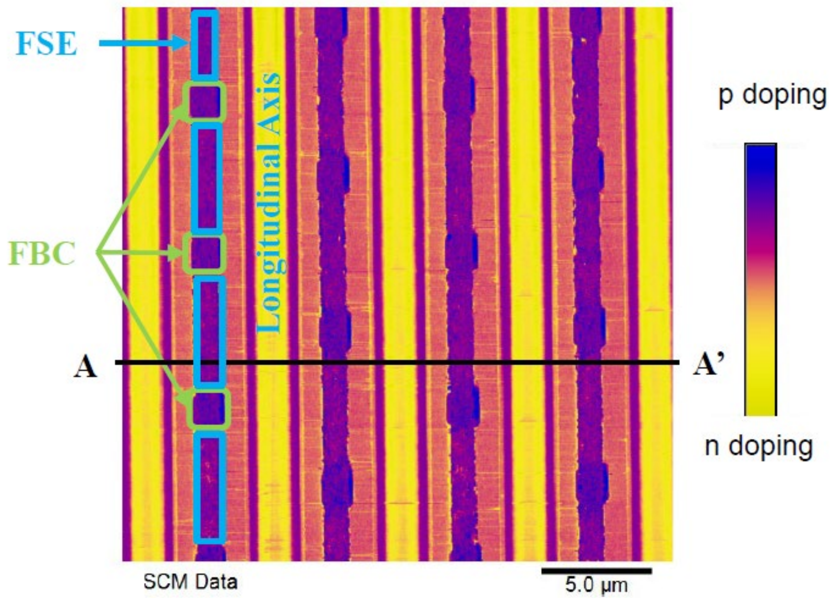
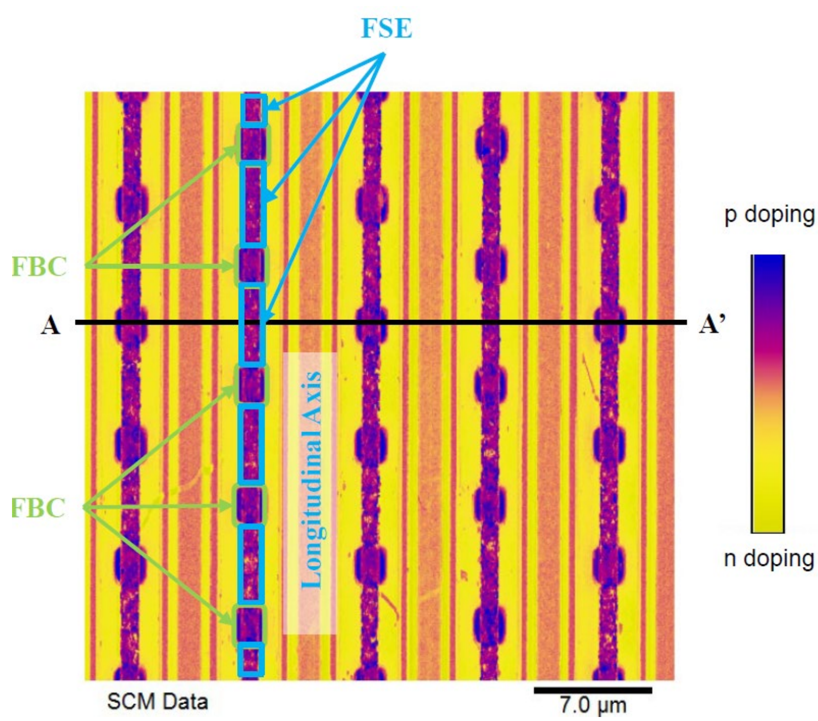
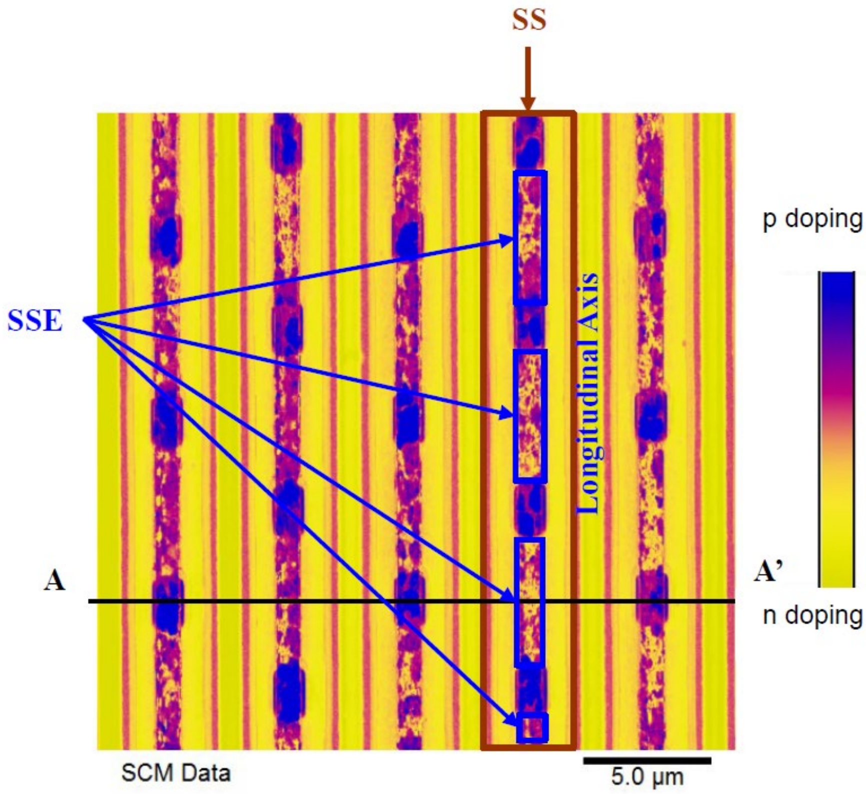
SCTW70N120G2V	
Tesla Inverter	

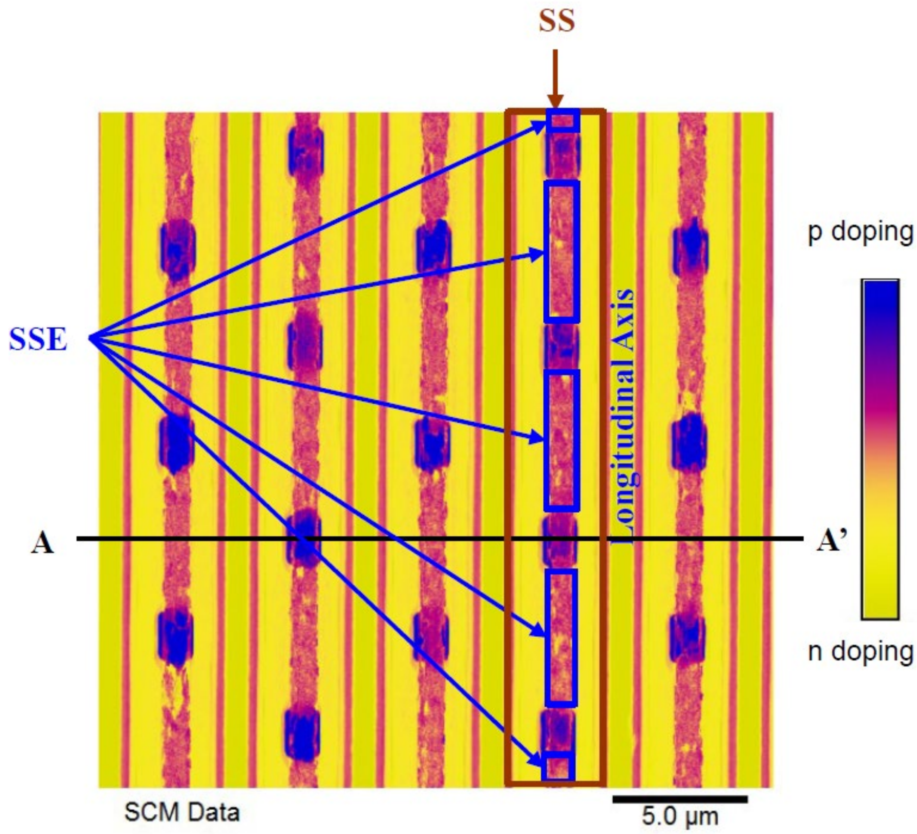
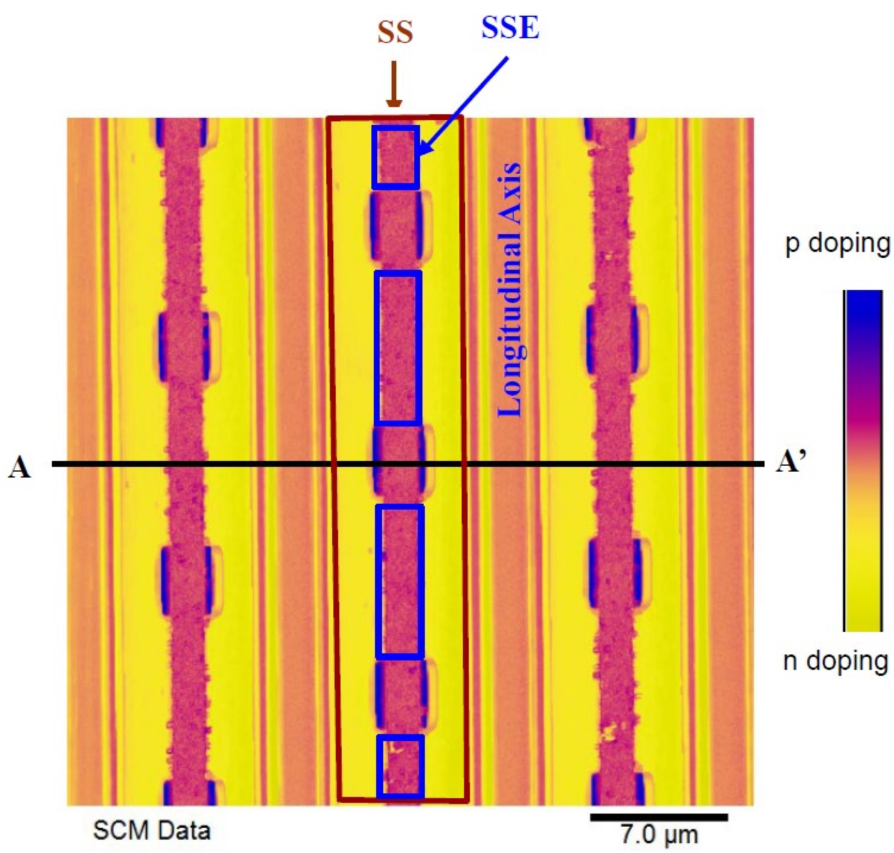
63. Given this, it is my opinion the Accused Products meet this limitation of claim 9.

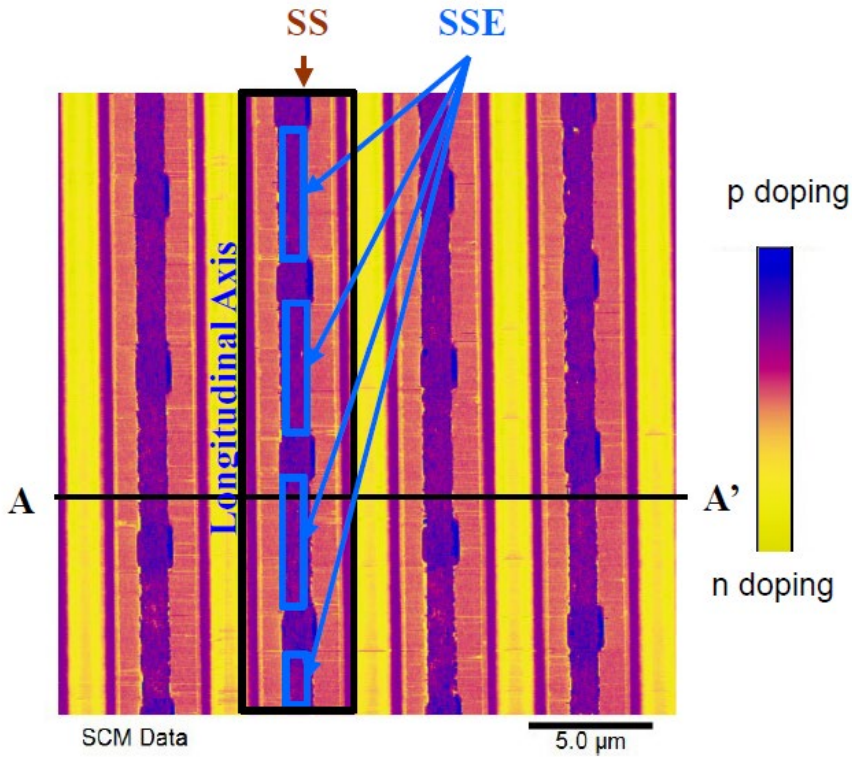
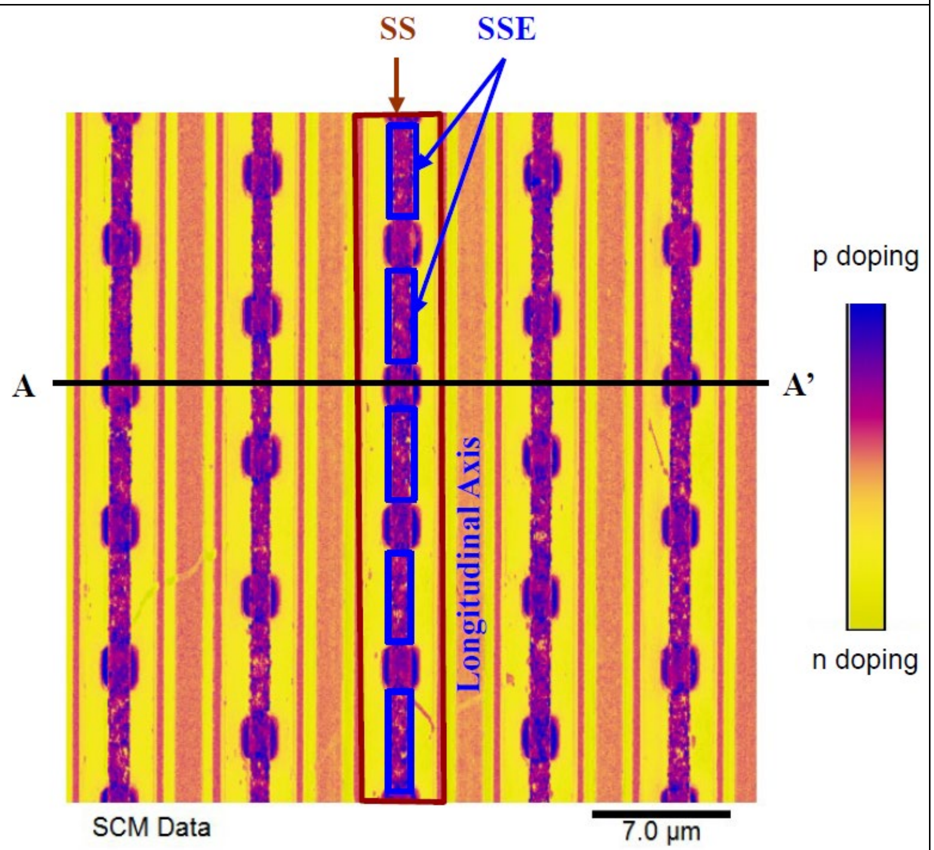
6. **<u>“a second source region”/ “a second source electrode formed over the second source region, the second source electrode defining a longitudinal axis”</u>**

64. Claim 9 requires “a second source region” and a “second source electrode formed over the second source region, the second source electrode defining a longitudinal axis.” These claim elements are substantively similar to the “first source region”/ “first source electrode” claim elements discussed above. And as discussed above, a person of ordinary skill in the art would understand that an electrode is where the metal touches the source region. In my view of the claim language, “first” and “second” source region refers to two separate locations where a source region is present, and "first" and "second" source electrode refers to two separate locations where the metal touches the "first" source region and where the metal touches the "second" source region. However, it should be noted that the specification contemplates that in some embodiments, the source electrodes are coupled together and may form a unitary source electrode. *See* ’633 Patent at 7:6-12 (“In some embodiments, the source electrodes 50, 52 are coupled together to form a unitary source electrode. Additionally, in some embodiments, the source electrodes are formed from two or more metallic materials such that one metallic material is coupled with the source regions 46, 48 and a second metallic material is coupled with the base contact regions 42, 44.”).

65. As before, the SCM imaging proves that the Accused and Representative products meet these claim limitations. In fact, the second source region and second electrode features can be considered to be the features adjacent to the identical first source region and first electrode features.

Representative Product	**Image**
SCT055HU65G3AG	

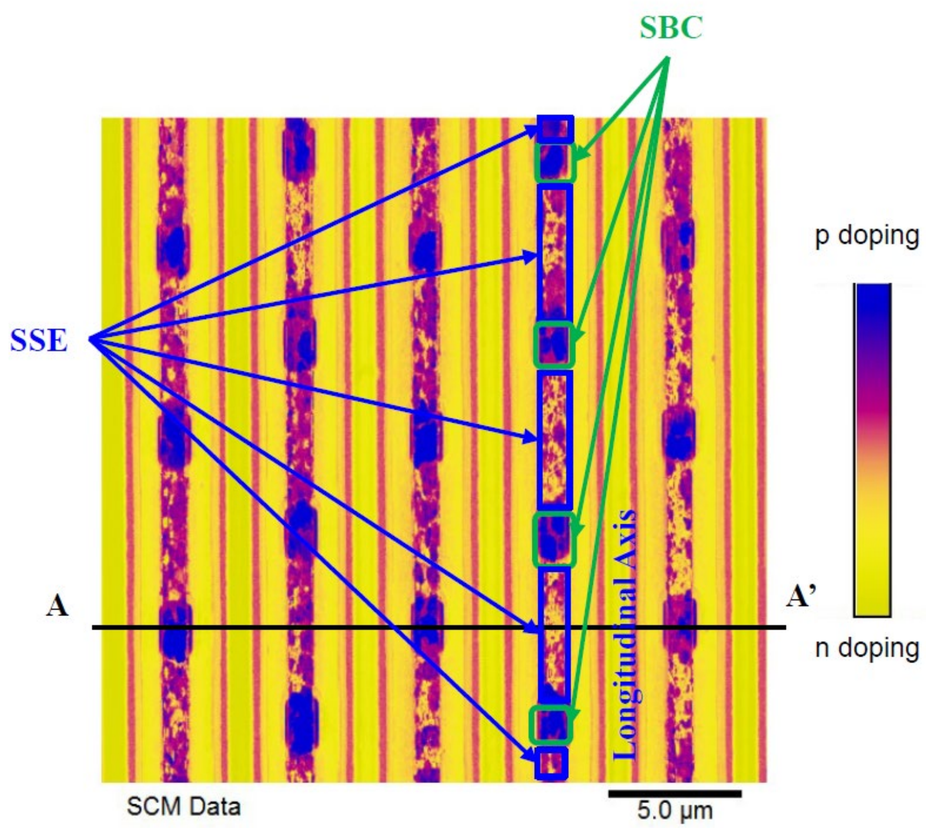
SCT040H65G3AG	
SCT1000N170	

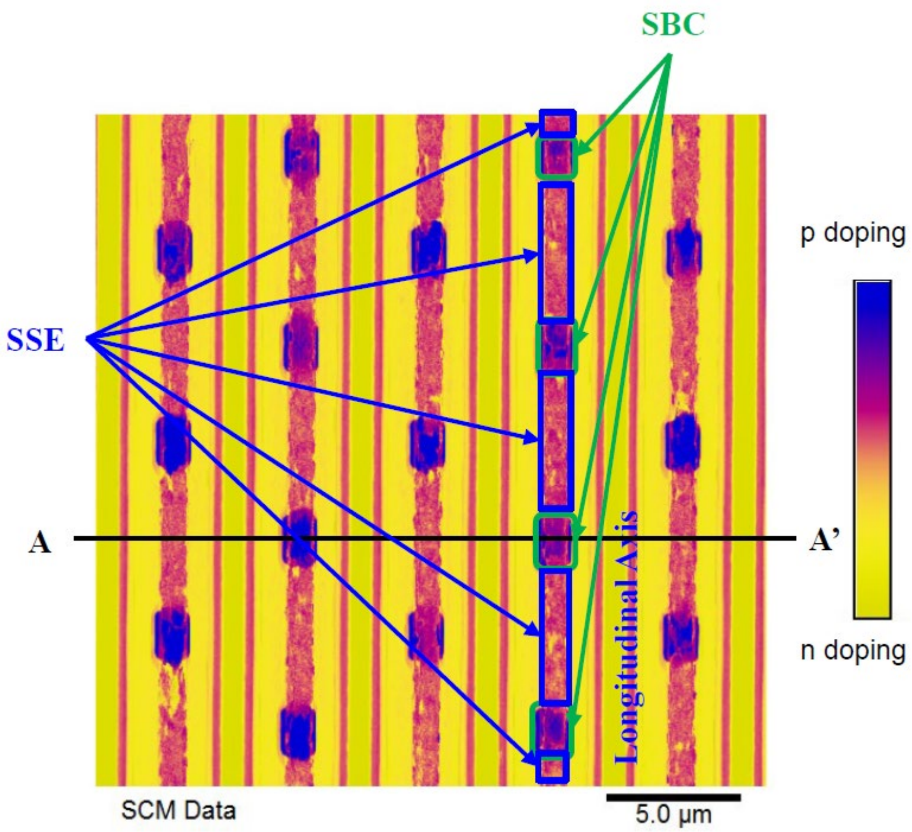
SCTW70N120G2V	
Tesla Inverter	

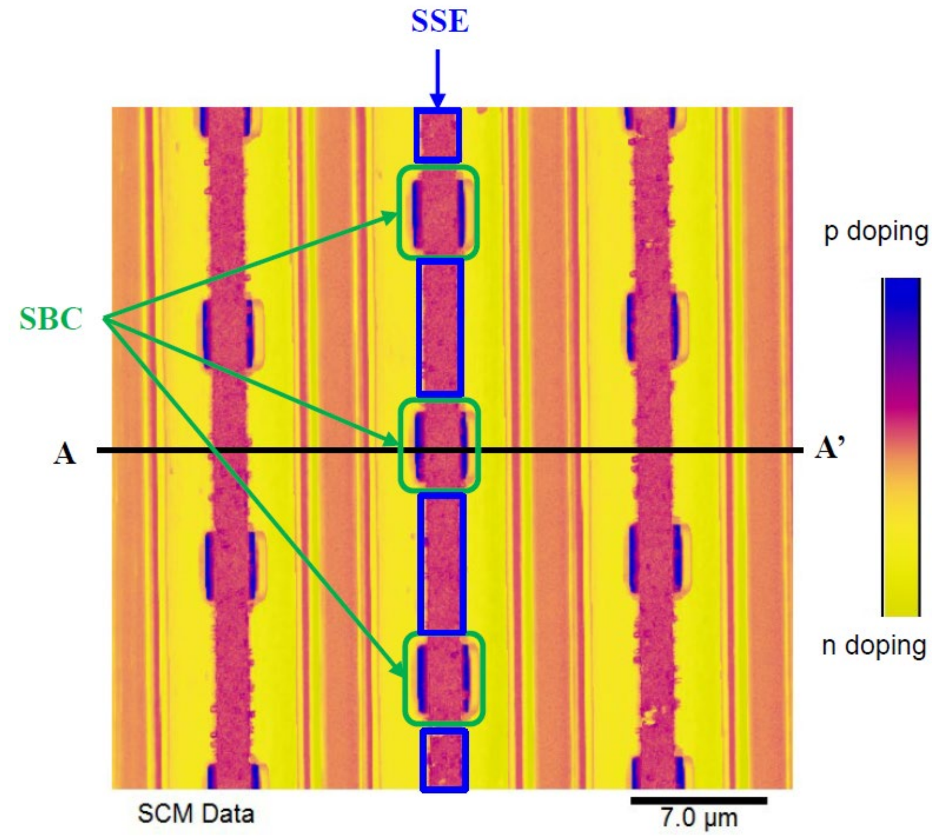
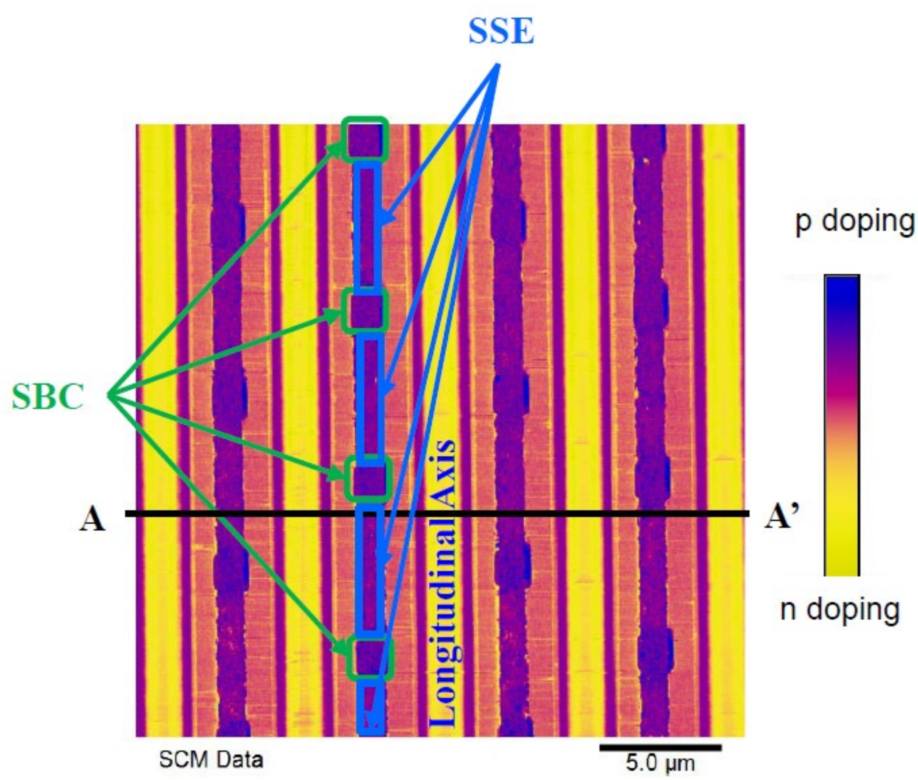
66. Given this, it is my opinion the Accused Products meet this limitation of claim 9.

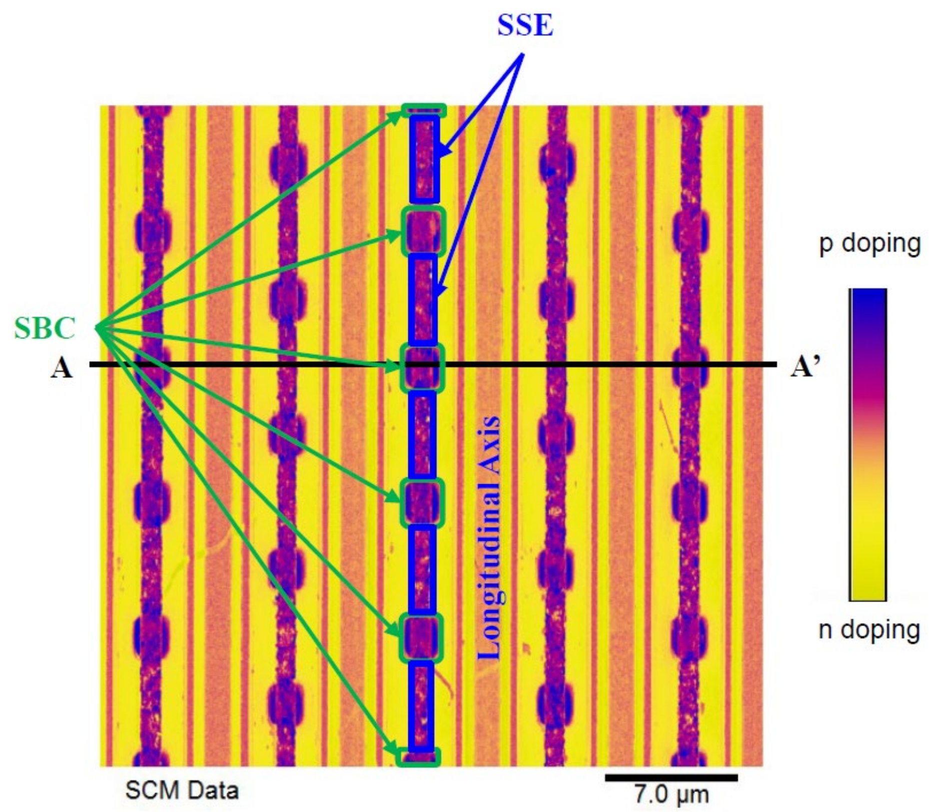
7. <u>"a plurality of second base contact regions defined in the second source region, each of the plurality of second base contact regions being spaced apart from each other in a direction parallel to the longitudinal axis defined by the second source electrode"</u>

67. The Accused and Representative Products include this limitation, which refers to the segmented base contacts described in the '633 Patent. The top-down views using scanning capacitance microscopy provide strong evidence that the Accused Products meet this limitation. And again, this claim element is substantively similar to the "plurality of first base contact regions" claim element discussed above.

Representative Product	**Image**
SCT055HU65G3AG	

SCT040H65G3AG	

SCT1000N170	
SCTW70N120G2V	

Tesla Inverter	

68. Given this, it is my opinion the Accused Products meet this limitation of claim 9.

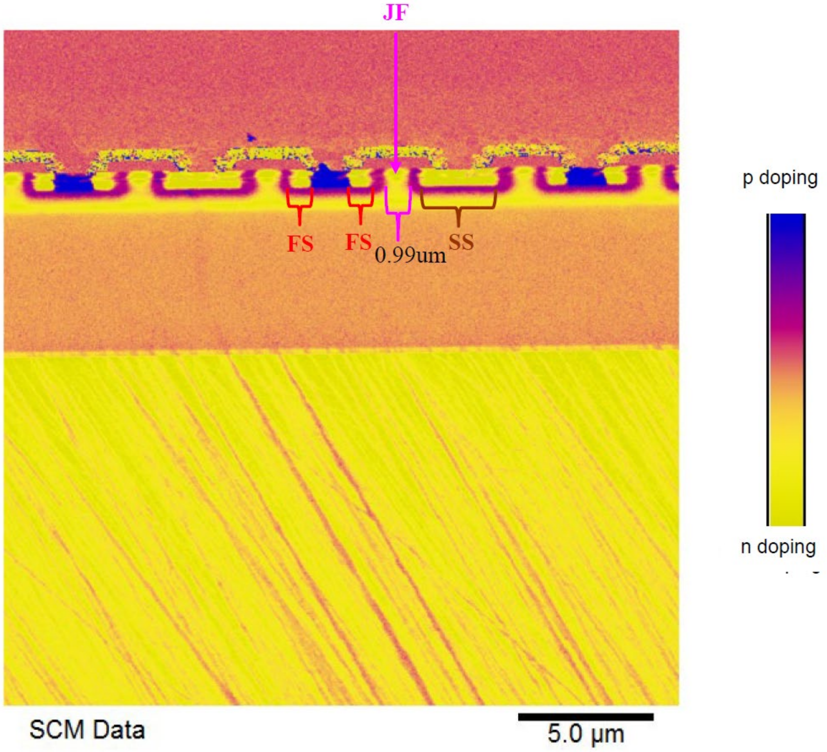
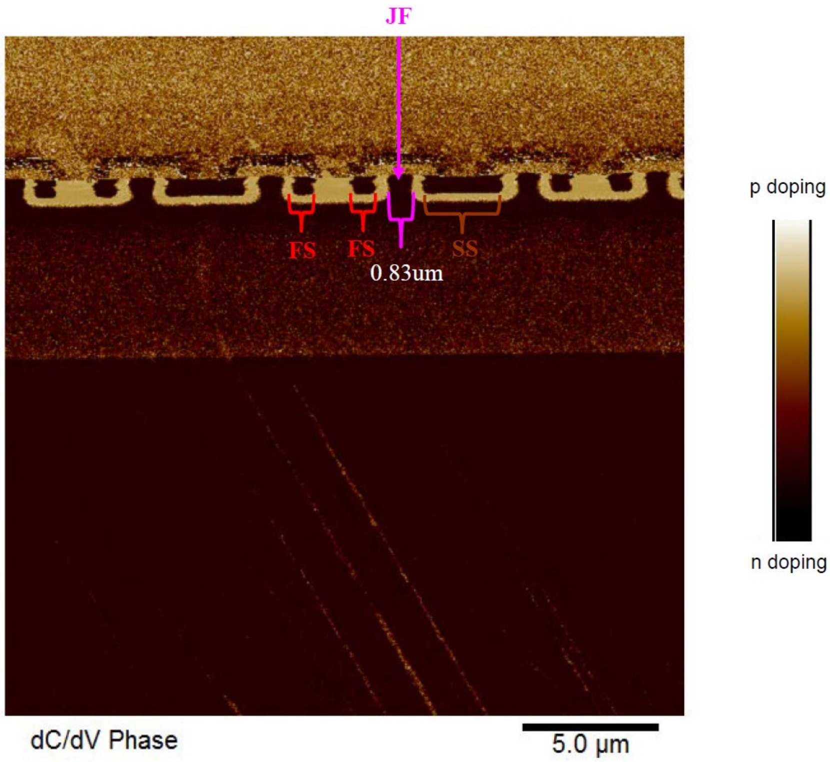
8. <u>"a JFET region defined between the first source region and the second source region, the JFET region having a width less than about three micrometers"</u>

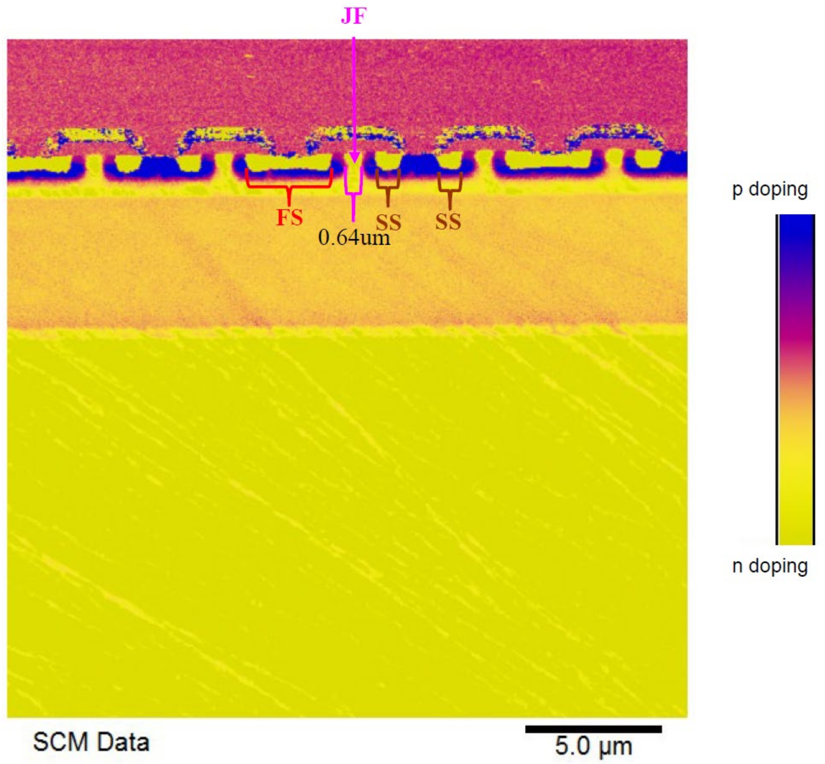
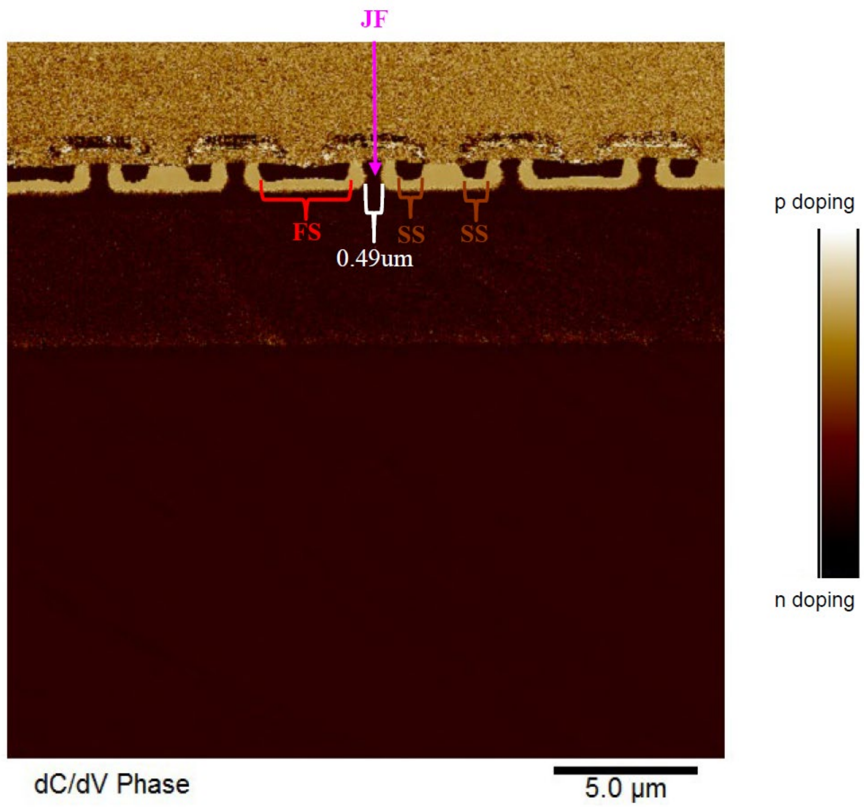
69. A JFET (junction field effect transistor) is a voltage-controlled transistor where current flow is due to the majority of charge carriers, meaning that JFETs are unipolar devices. JFETs have three terminals: source, drain, and gate, with the gate consisting of a portion or region of the semiconductor itself. Typically, JFETs are always on devices such that when voltage is applied, the current stops (or is reduced). In that sense, like most transistors, JFETs can act like a switch.

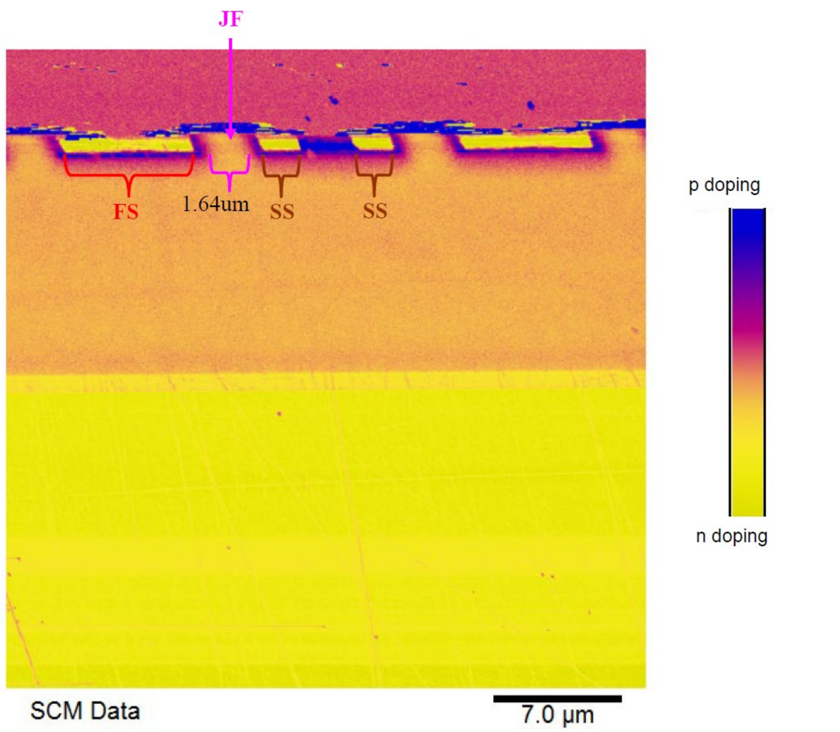
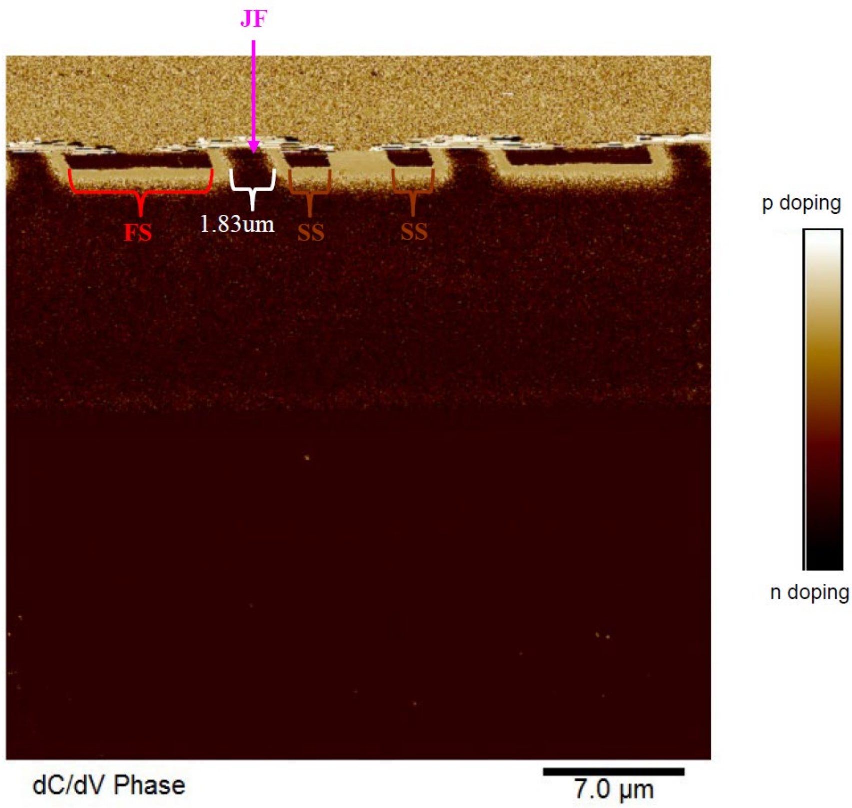
70. This claim states that there is a JFET region between the first and second source regions that has a width of less than about three microns. As a skilled artisan would readily understand and as the specification explains, the JFET region is located between the p-wells, labeled 26 and 28 in Figure 1 of the ’633 Patent. The Court stated that the term “less than about three micrometers” should have its plain and ordinary meaning. In that sense, any measurement less than 3.3 or so microns would fall within the scope of the claims in my opinion, given the semiconductor manufacturing variances and equipment tolerances. That is, “about three micrometers” in my view implicates a 10% variance at 3 microns.

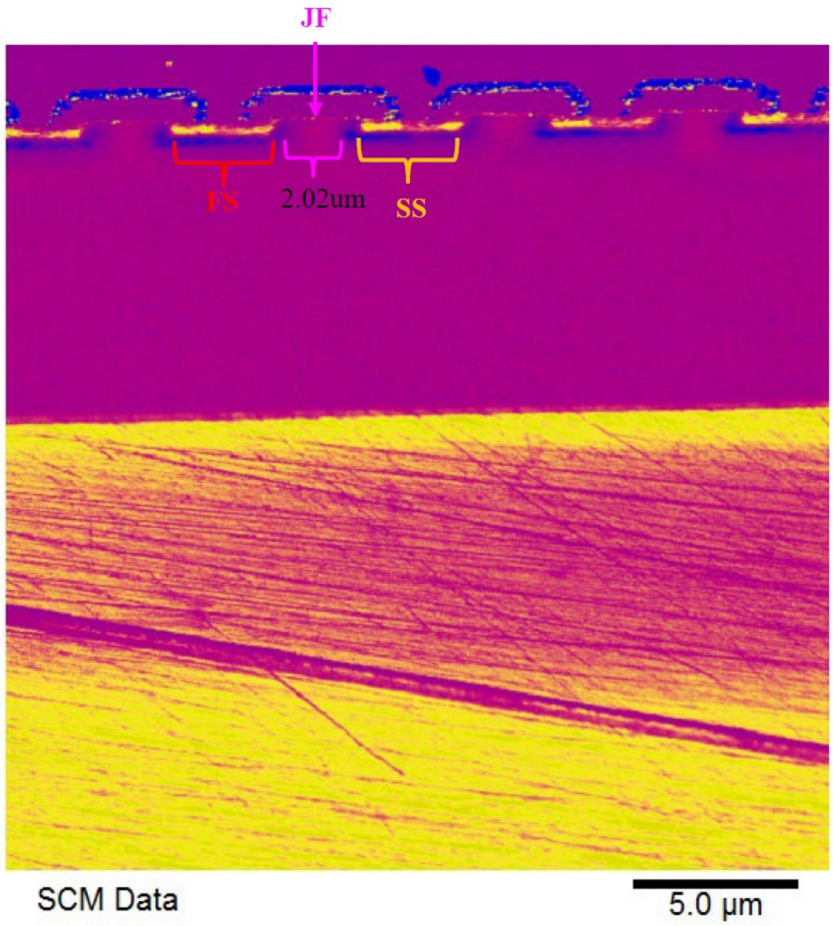
71. Measurements taken using the SCM images demonstrate that there is a JFET region in each of the Accused and Representative Products that has a width less than about three microns. The measurements were taken using a Microsoft Ruler tool, and are consistent with the scale provided by the SCM equipment. The measurements differ based on the resolution of the SCM or SEM images. In any event, the JFET region in each product is less than about three microns.

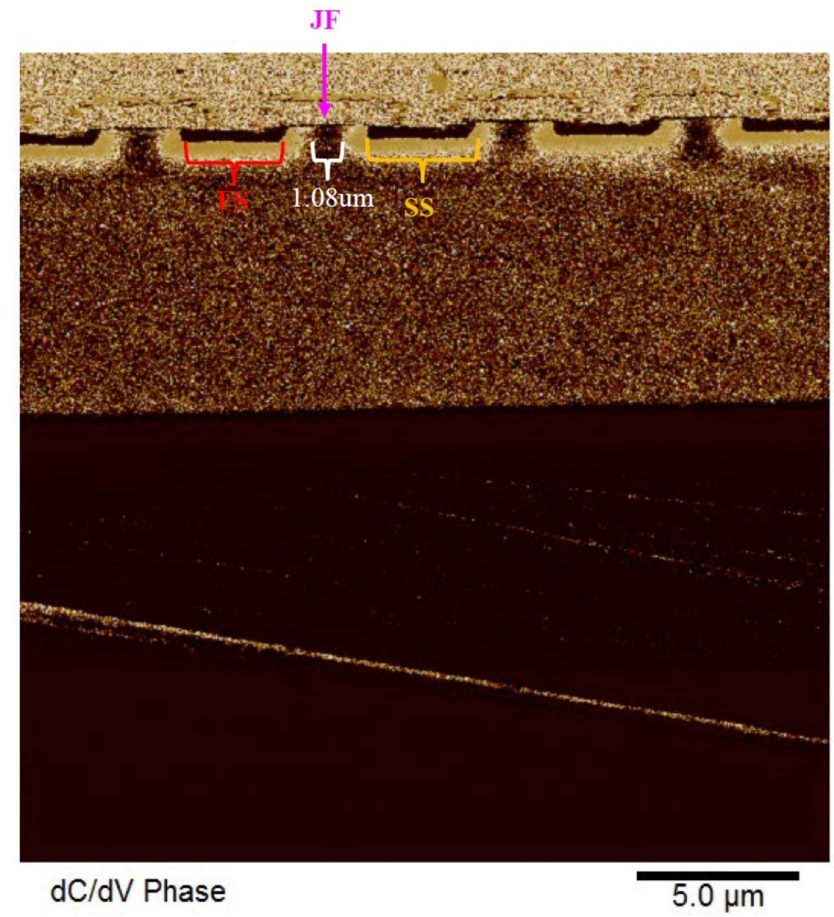
Representative Product	**Image**

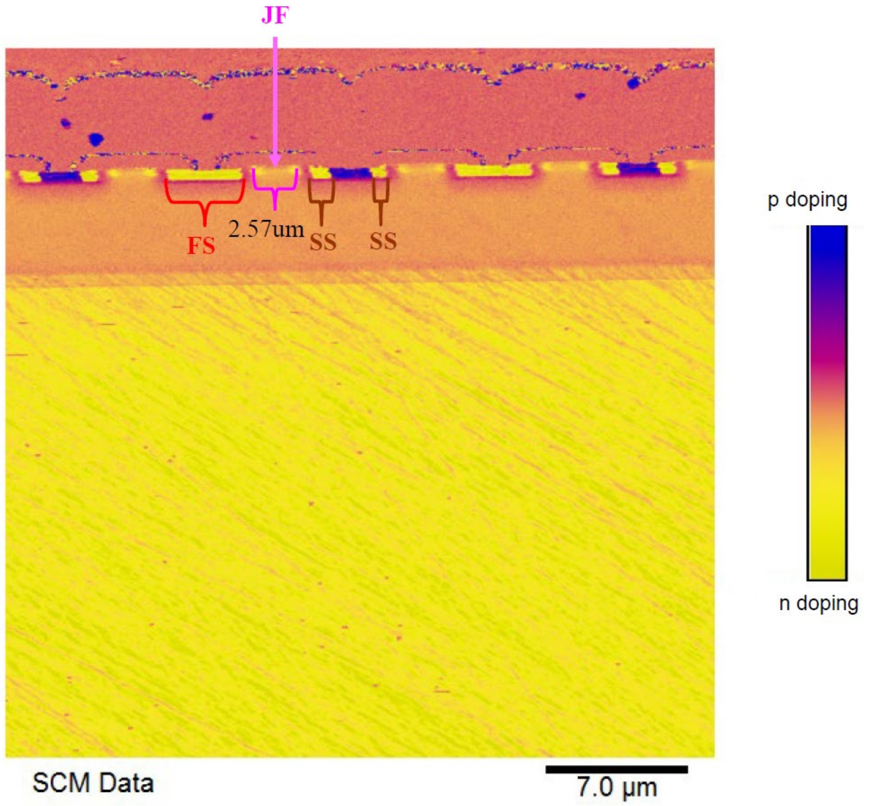
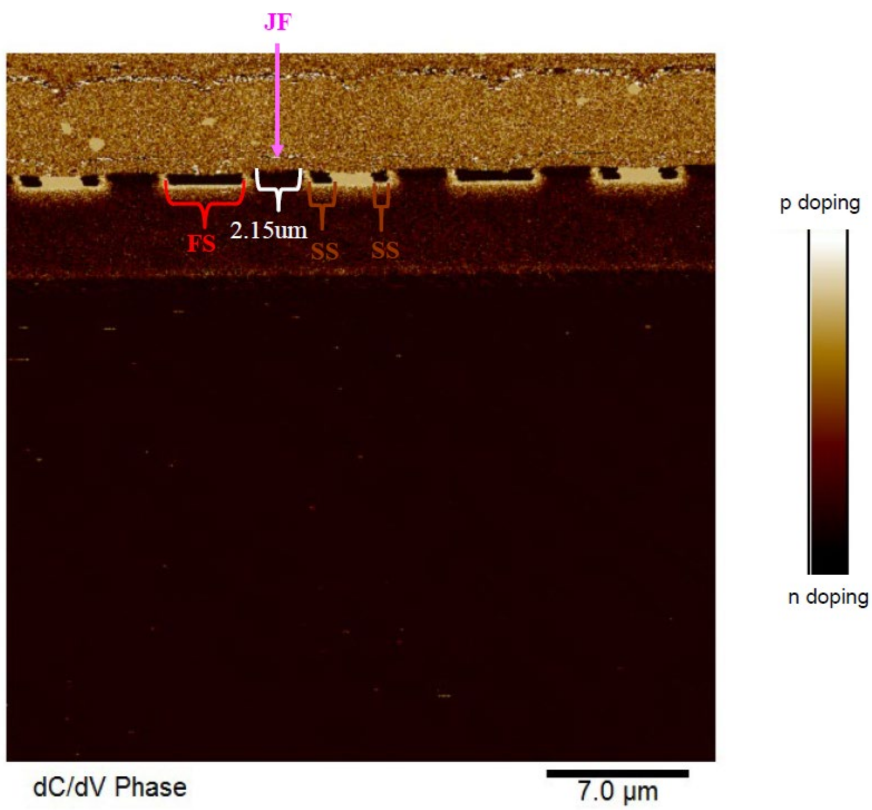
SCT055HU65G3AG	 

SCT040H65G3AG	 

SCT1000N170	 

<table>
<tr><td>SCTW70N120G2V</td><td>
</td></tr>
</table>

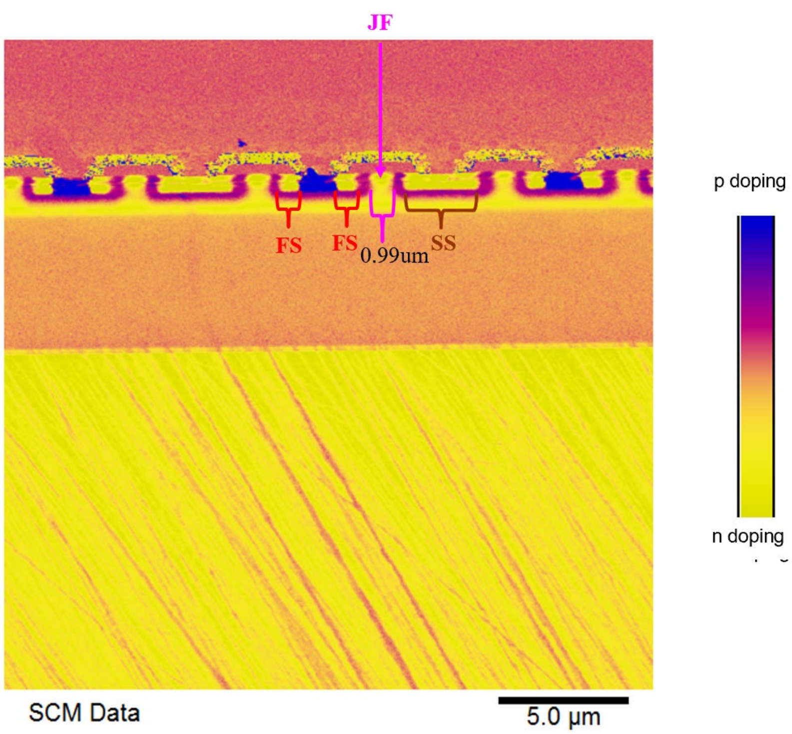
	JF FS 1.08um SS dC/dV Phase 5.0 µm

Tesla Inverter	 

72. Given this, it is my opinion that the Accused Products meet this limitation of claim 9. And given that the Accused Products meet all the limitations of claim 9, it is my opinion that the Accused Products infringe claim 9 of the '633 Patent.

B. <u>The Accused Products Infringe Claim 10</u>

73. Claim 10 depends from claim 9, and states: "The double-implanted metal-oxide semiconductor field-effect transistor of claim **9,** wherein the JFET region has a width of about one micrometer." I understand that all third-generation silicon carbide DMOSFETs produced by Defendants are likely to have narrow JFET regions. Representative Product SCT055HU65G3AG has a JFET region width of .99 microns when measured using the SCM images.



The cross-section scanning capacitance microscopy.

74. Accordingly, the Accused Products of which SCT055HU65G3AG is representative infringe claim 10 of the '633 Patent.